NUTRITION AND DIETETICS

HIGHER SECONDARY - FIRST YEAR

Untouchability is a sin
Untouchability is a crime
Untouchability is inhuman

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PREFACE

This book is the outcome of the apt decision of the Directorate of School Education, Government of Tamilnadu to introduce Nutrition and Dietetics as an optional subject at Higher Secondary level.

People are becoming nutrition conscious. Print and electronic media pour out nutrition messages to the public. Super markets are flooded with foods of varied types, natural, processed, and ready to eat. The common man turns towards nutrition scientists and dietitians for scientifically proved information on Nutrition and Dietetics. Hence it is essential that Nutrition and Dietetics is offered at various levels of education.

This textbook on Nutrition and Dietetics includes content on Food Science and Nutrition at plus one level, while at plus two level on Family Meal Management and Dietetics. At plus one level the student learns the rudimentary aspects while at plus two level the application aspects are included. The contents are so arranged that the student gains knowledge with application and skill.

The authors collected scientifically proved and updated information from various authentic sources. The reviewers and chairman offered valuable suggestions on the write up. It is hoped that the students will understand Nutrition and Dietetics in the right perspective using this book.

Grateful acknowledgement is expressed to the Director and Joint Director, School Education, Government of Tamilnadu for this enriching opportunity.

1. FOOD GROUPS – A GUIDE IN MENU PLANNING

Food is the basic necessity of man. It is a mixture of different nutrients such as carbohydrate, protein, fat, vitamins and minerals. These nutrients are essential for growth, development and maintenance of good health throughout life. They also play a vital role in meeting the special needs of pregnant and lactating women and patients recovering from illness.

1.1 FUNCTIONS OF FOOD

Food may be classified according to their functions in the body.

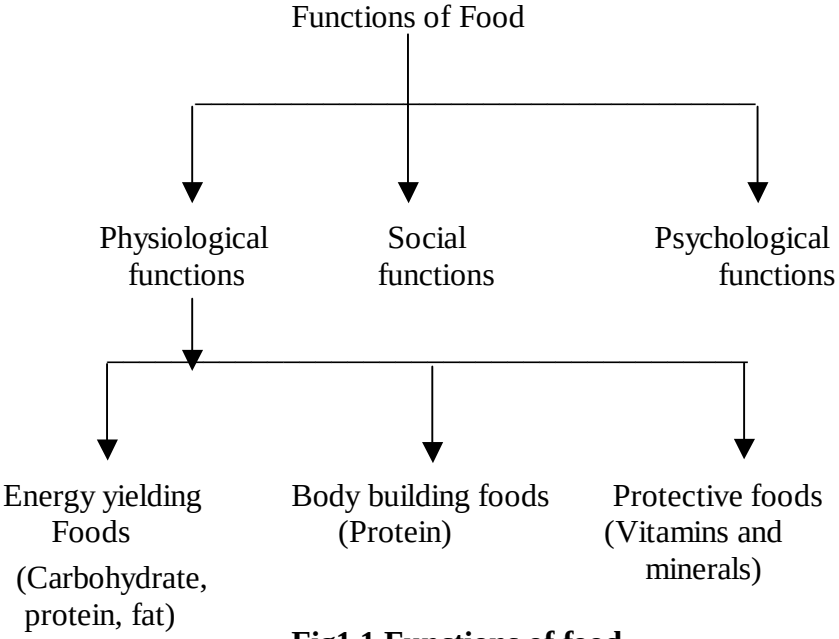


Fig1.1 Functions of food

Physiological functions of food:

i. **Energy yielding foods:**

Foods rich in carbohydrates and fats are called energy yielding foods. They provide energy to sustain the involuntary processes essential for continuance of life, to carry out various professional, household and recreational activities and to convert food ingested into usable nutrients in the body.

The energy needed is supplied by the oxidation of foods consumed. Cereals, roots and tubers, dried fruits, oils, butter and ghee are all good sources of energy.

ii. **Body building foods:**

Foods rich in protein are called body building foods. Milk, meat, eggs and fish are rich in proteins of high quality. Pulses and nuts are good sources of protein but the protein is not of high quality. These foods help to maintain life and promote growth. They also supply energy.

iii. **Protective and Regulatory foods:**

Foods rich in protein, minerals and vitamins are known as protective and regulatory foods. They are essential for health and regulate activities such as maintenance of body temperature, muscle contraction, control of water balance, clotting of blood, removal of waste products from the body and maintaining heartbeat. Milk, egg, liver, fruits and vegetables are protective foods.

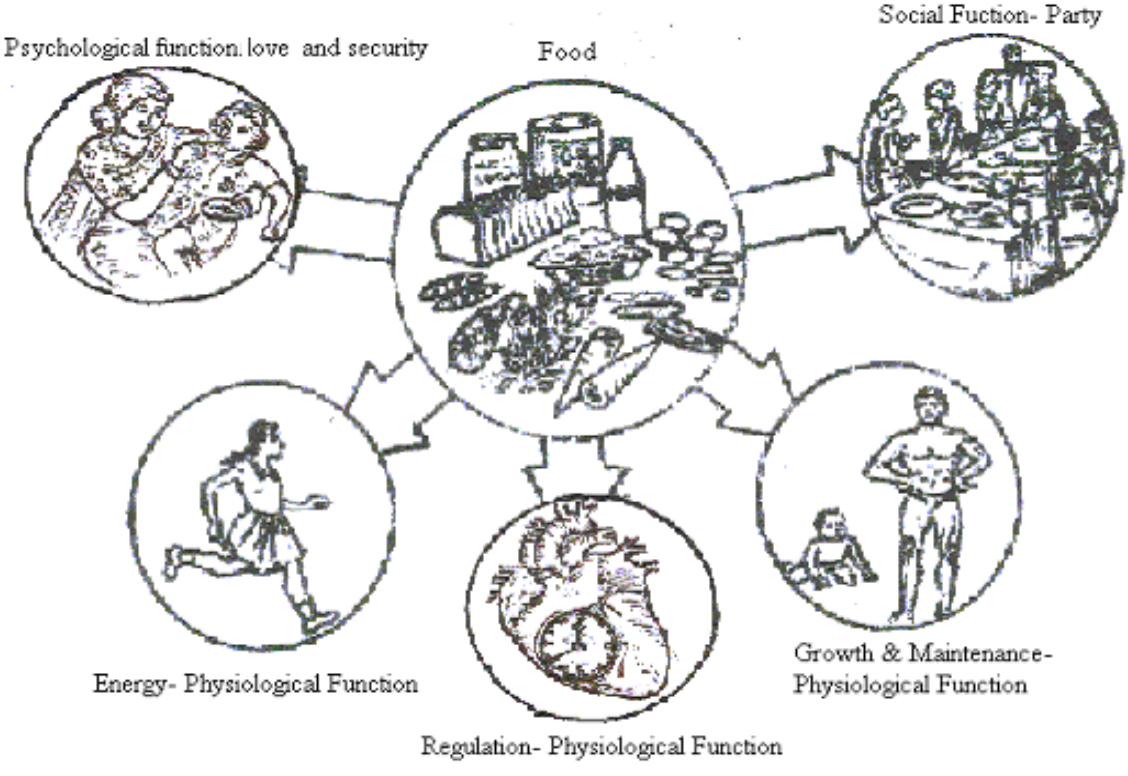
Social functions of food:

Food has always been the central part of our community, social, cultural and religious life. It has been an expression of love, friendship and happiness at religious, social and family get-togethers.

Psychological functions of food:

In addition to satisfying physical and social needs, foods also satisfy certain emotional needs of human beings. These include a sense of security, love and acceptance. For example, preparation of delicious foods for family members is a token of love and affection.

Fig.1.2 -Functions of food



1.2 ICMR FIVE FOOD GROUPS

TABLE – 1.A
Five Food Group System

Food Group	Main Nutrients
I. Cereals, Grains and Products : Rice, Wheat, Ragi, Bajra, Maize, Jowar, Barley, Rice flakes, Wheat flour.	Energy, protein, Invisible fat Vitamin – B_1, Vitamin – B_2, Folic Acid, Iron, Fibre.
II. Pulses and Legumes : Bengal gram, Black gram, Green gram, Red gram, Lentil (whole as well as dhals) Cowpea, Peas, Rajmah, Soyabeans, Beans.	Energy, Protein, Invisible fat, Vitamin – B_1, Vitamin – B_2, Folic Acid, Calcium, Iron, Fibre.
III. Milk and Meat Products : **Milk :** Milk, Curd, Skimmed milk, Cheese **Meat :** Chicken, Liver, Fish, Egg, Meat.	Protein, Fat, Vitamin – B_{12}, Calcium. Protein, Fat, Vitamin – B_2
IV. Fruits and Vegetables : **Fruits :** Mango, Guava, Tomato Ripe, Papaya, Orange. Sweet Lime, Watermelon. **Vegetables (Green Leafy)** : Amaranth, Spinach, Drumstick leaves, Coriander leaves, Mustard leaves, fenugreek leaves . **Other Vegetables** : Carrots, Brinjal, Ladies fingers, Capsicum, Beans, Onion, Drumstick, Cauliflower.	 Carotenoids, Vitamin – C, Fibre. Invisible Fats, Carotenoids, Vitamin – B_2. Folic Acid, Calcium, Iron, Fibre. Carotenoids, Folic Acid, Calcium, Fibre

Food Group	Main Nutrients
V. Fats and Sugars :	
Fats :	
Butter, Ghee, Hydrogenated oils, Cooking oils like Groundnut, Mustard, Coconut.	Energy, Fat, Essential Fatty Acids
Sugars :	
Sugar, Jaggery	Energy

Source :

Gopalan. C, Rama Sastri B.V. and Balasubramanian S.C., 1989, Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad.

Significance of the five-food group system

The five food group system can be used for the following purposes :

i. Planning wholesome balanced menus to achieve nutritional adequacy.

ii. Assessing nutritional status – a brief diet history of an individual can disclose inadequacies of food and nutrients from any of the five groups.
Based on the assessment, nutrition education can be imparted to the individual.

1.3. FOOD PYRAMID :

The food guide pyramid was introduced in 1992 by USDA (United States Department of Agriculture) as a general plan of what to eat each day. The food guide pyramid is a valuable tool for planning a health promoting diet.

By incorporating the principle of balance, variety and moderation, an individual can still eat their favourite foods while following the food guide pyramid.

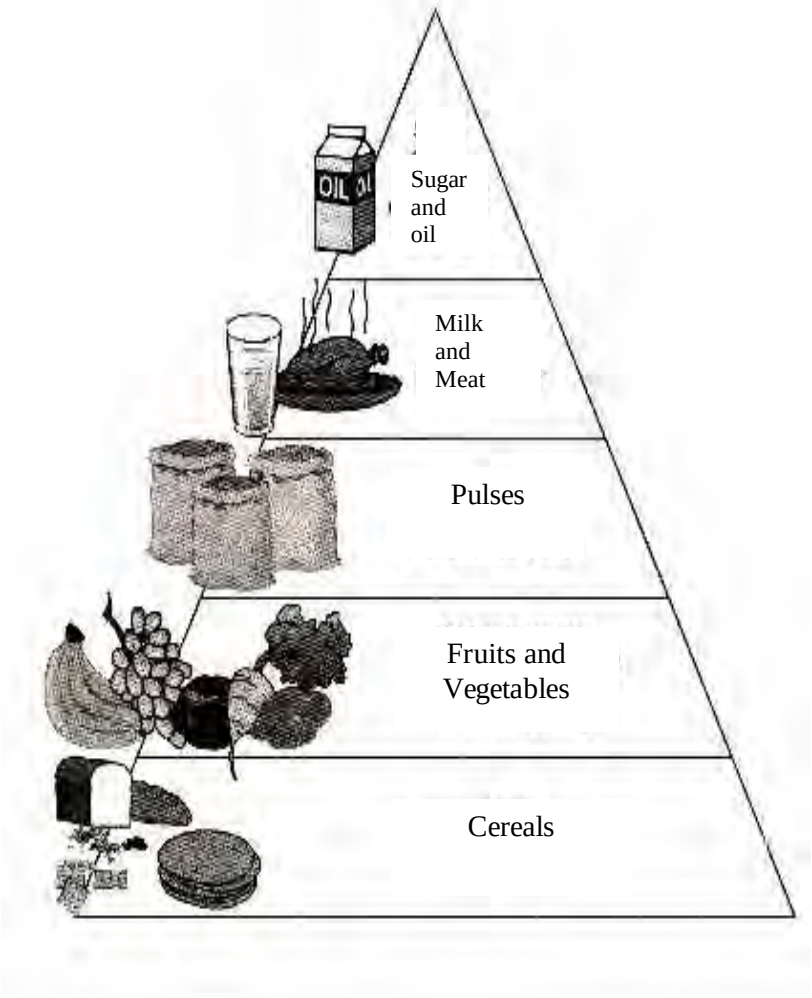


Fig.1.3 -Food guide pyramid

Source:

Srilakshmi .B 2003.Dietetics, New Age International (P) Publishers Ltd.Chennai.

Balance:

It means choosing food from different food groups.

Variety:

This means including different foods within each food group. For eg. consuming a variety of fruits.

Moderation:

This means keeping serving sizes reasonable. This involves self control.

The food guide pyramid provides recommendation for the number of daily servings that should be consumed from each of the food groups.

The diagram Fig. 1.3, clearly represents that cereals should form the major bulk of the diet followed by fruits and vegetables, pulses, milk and meat products and sugars and oil. The portion size of foods for adolescents (13-18 years) is given below.

TABLE 1.B

Portion size of foods for adolescents

Food Groups	Portion Size	Number of Portions for Adolescents	
		Girls	Boys
Cereals and millets	30 g	10	14
Pulses	30 g	2	2
Milk	100 ml	5	5
Roots and tubers	100 g	1	2
Green leafy Vegetables	100 g	1	1
Other vegetables	100 g	1	1
Fruits	100 g	1	1
Sugar	5 g	6	7
Fats and oils	5 g	5	5

(For non-vegetarians substitute one pulse portion with one portion (50 gm) of egg / meat / chicken / fish.)

Source :

Dietary guidelines for Indians – A manual (1998), National Institute of Nutrition, ICMR, Hyderabad – 500 007.

Questions

Part- A

Fill in the blanks:

1. Foods rich in carbohydrate and fats are called _____ foods.
2. Foods rich in _____ are called body building foods.
3. Foods rich in protein vitamins and minerals are called _____ foods.
4. The food guide pyramid is based on the principles of _____ , _____ and _____.

Part- B

Write short answers:

1. How are foods classified?. Mention the physiological functions of food.
2. Give the ICMR classification of food groups.
3. List the major nutrients present in fruits and vegetables.
4. Give the portion size of foods for adolescents.

Part- C

Write detailed answers:

1. Explain the functions of food. Enumerate the purpose of the five-food group system.
2. Give a diagrammatic representation of the food pyramid and highlight its role as a guide in menu planning.

2. COOKING METHODS – MERITS AND DEMERITS

Food preparation is an important step in meeting the nutritional needs of the family. Food has to be pleasing in appearance and taste in order to be consumed. Foods like fruits, vegetables and nuts can be eaten raw but most foods are cooked to bring about desirable changes. The process of subjecting food to the action of heat is termed as cooking.

Objectives of Cooking

1. Cooking sterilizes food: Above 40° C the growth of bacteria decreases rapidly. Hence food is made safe for consumption.
2. Cooking softens the connective tissues of meat and the coarse fibre of cereals, pulses and vegetables so that the digestive period is shortened and the gastro intestinal tract is less subjected to irritation.
3. Palatability and food quality is improved by cooking – Appearance, flavour, texture and taste of food are enhanced while cooking.
4. Introduces variety – Different dishes can be prepared with the same ingredients. (Eg.) Rice can be made into biriyani and kheer.
5. Increases food consumption – Cooking brings about improvement in texture and flavour thereby increasing consumption of food.
6. Increases availability of nutrients – Example in raw egg, avidin binds biotin making it unavailable to the body. By cooking, avidin gets denatured and biotin is made available.

2.1 COOKING METHODS

Heat is transferred to the food during cooking by conduction, convection, radiation or microwave energy. Cooking takes place by moist and dry heat. Moist heat involves water and steam. Air or fat are used in dry heat.

TABLE – 2A

Cooking methods

Moist Heat	Dry Heat	Combination
Boiling	Roasting	Braising
Stewing	Grilling	
Steaming	Toasting	
Pressure Cooking	Baking	
Poaching	Sauteeing	
Blanching	Frying	

2.2 MOIST HEAT METHODS

2.2.1 Boiling:

Boiling is a method of cooking foods by just immersing them in water at 100° C and maintaining the water at that temperature till the food is tender. Rice, egg, dhal, meat, roots and tubers are cooked by boiling.

Merits

1. Simple method - It does not require special skill and equipment.
2. Uniform cooking can be achieved.

Demerits

1. Continuous excessive boiling leads to damage in the structure and texture of food.
2. Loss of heat labile nutrients such as B and C vitamins if the water is discarded.
3. Time consuming – Boiling takes more time to cook food and fuel may be wasted.
4. Loss of colour – water soluble pigments may be lost.

2.2.2 Stewing

It refers to the simmering of food in a pan with a tight fitting lid using small quantities of liquid to cover only half the food. This is a slow method of cooking. The liquid is brought to boiling point and the heat is reduced to maintain simmering temperatures (82°C - 90° C). The food above the liquid is cooked by the steam generated within the pan. Apple, meat along with roots, vegetables and legumes are usually stewed.

Merits

1. Loss of nutrients is avoided as water used for cooking is not discarded.
2. Flavour is retained.

Demerits

1. The process is time consuming and there is wastage of fuel.

2.2.3 Steaming:

It is a method of cooking food in steam generated from vigorously boiling water in a pan.

The food to be steamed is placed in a container and is not in direct contact with the water or liquid. Idli, custard and idiappam are made by steaming. Vegetables can also be steamed.

Merits

1. Less chance of burning and scorching.
2. Texture of food is better as it becomes light and fluffy. Eg. Idli.
3. Cooking time is less and fuel wastage is less.
4. Steamed foods like idli and idiappam contain less fat and are easily digested and are good for children, aged and for therapeutic diets.
5. Nutrient loss is minimised.

Demerits

1. Steaming equipment is required.
2. This method is limited to the preparation of selected foods.

2.2.4 Pressure cooking:

When steam under pressure is used the method is known as pressure cooking and the equipment used is the pressure cooker. In this method the temperature of boiling water can be raised above 100° C. Rice, dhal, meat, roots and tubers are usually pressure cooked.

Merits

1. Cooking time is less compared to other methods.
2. Nutrient and flavour loss is minimised.
3. Conserves fuel and time as different items can be cooked at the same time.
4. Less chance for burning and scorching.
5. Constant attention is not necessary.

Demerits

1. The initial investment may not be affordable to everybody.
2. Knowledge of the usage, care and maintenance of cooker is required to prevent accidents.
3. Careful watch on the cooking time is required to prevent over cooking.

2.2.5 Poaching:

This involves cooking in the minimum amount of liquid at temperatures of 80° C - 85° C that is below the boiling point. Egg and fish can be poached.

Merits

1. No special equipment is needed.
2. Quick method of cooking and therefore saves fuel.
3. Poached foods are easily digested since no fat is added.

Demerits

1. Poached foods may not appeal to everybody as they are bland in taste.
2. Food can be scorched if water evaporates due to careless monitoring.
3. Water soluble nutrients may be leached into the water.

2.2.6 Blanching:

In meal preparation, it is often necessary only to peel off the skin of fruits and vegetables without making them tender. This can be achieved by blanching. In this method, food is dipped in boiling water for 5 seconds to 2 minutes depending on the texture of the food. This helps to remove the skin or peel without softening food.

Blanching can also be done by pouring enough boiling water on the food to immerse it for some time or subjecting foods to boiling temperatures for short periods and then immediately immersing in cold water. The process causes the skin to become loose and can be peeled off easily.

Merits

1. Peels can easily be removed to improve digestibility.
2. Destroys enzymes that bring about spoilage.
3. Texture can be maintained while improving the colour and flavour of food.

Demerits

1. Loss of nutrients if cooking water is discarded.

2.3 DRY HEAT METHODS

2.3.1 Roasting:

In this method food is cooked in a heated metal or frying pan without covering it. Eg. Groundnut.

Merits

1. Quick method of cooking.
2. It improves the appearance, flavour and texture of the food.
3. Spices are easily powdered if they are first roasted.

Demerits

1. Food can be scorched due to carelessness.
2. Roasting denatures proteins reducing their availability.

2.3.2 Grilling:

Grilling or broiling refers to the cooking of food by exposing it to direct heat. In this method food is placed above

or in between a red hot surface. Papads, corn, phulkas, chicken can be prepared by this method.

Merits

1. Enhances flavour, appearance and taste of the product.
2. It requires less time to cook.
3. Minimum fat is used.

Demerits

1. Constant attention is required to prevent charring.

2.3.3 Toasting:

This is a method where food is kept between two heated elements to facilitate browning on both sides. Bread slices are cooked by toasting.

Merits

1. Easy and quick method.
2. Flavour improved.

Demerits

1. Special equipment required.
2. Careful monitoring is needed to prevent charring.

2.3.4 Baking:

In this method, the food gets cooked in an oven or oven-like appliance by dry heat. The temperature range maintained in an oven is 120°C – 260°C.

The food is usually kept uncovered in a container greased with a fat coated paper. Bread, cake, biscuits, pastries and meat are prepared by this method.

Merits

1. Baking lends a unique baked flavour to foods.
2. Foods become light and fluffy – cakes, custards, bread.
3. Certain foods can be prepared only by this method – bread, cakes.
4. Uniform and bulk cooking can be achieved. Eg. bun, bread.
5. Flavour and texture are improved.
6. Variety of dishes can be made.

Demerits

1. Special equipment like oven is required.
2. Baking skills are necessary to obtain a product with ideal texture, flavour and colour characteristics.
3. Careful monitoring needed to prevent scorching.

2.3.5 Sauteing:

Sauteing is a method in which food is lightly tossed in little oil just enough to cover the base of the pan. The pan is covered with a lid and the flame or intensity of heat is reduced.

The food is allowed to cook till tender in its own steam. The food is tossed occasionally, or turned with a spatula to enable all the pieces to come in contact with the oil and get cooked evenly.

The product obtained by this method is slightly moist and tender but without any liquid or gravy. Foods cooked by sauteing are generally vegetables which are used as side dishes in a menu. Sauteing can be combined with other methods to produce variety in meals.

Merits

1. Takes less time.
2. Simple technique.
3. Minimum oil is used.

Demerits

1. Constant attention is needed as there is chance of scorching or burning.

2.3.6 Frying:

In this method, the food to be cooked is brought into contact with larger amount of hot fat. When food is totally immersed in hot oil, it is called deep fat frying. Samosa, chips, pakoda are examples of deep fat fried foods. In shallow fat frying, only a little fat is used and the food is turned in order that both sides are browned. Eg. Omlette, cutlets, parathas.

Merits

1. Very quick method of cooking.
2. The calorific values of food is increased since fat is used as the cooking media.
3. Frying lends a delicious flavour and attractive appearance to foods.
4. Taste and texture are improved.

Demerits

1. Careful monitoring is required as food easily gets charred when the smoking temperature is not properly maintained.
2. The food may become soggy due to too much oil absorption.
3. Fried foods are not easily digested.
4. Repeated use of heated oils will have ill effects on health.

2.4 COMBINATION OF COOKING METHODS

Braising :

Braising is a combined method of roasting and stewing in a pan with a tight fitting lid. Flavourings and seasonings are added and food is allowed to cook gently. Food preparations prepared by combination methods are :

Uppuma	-	Roasting and boiling.
Cutlet	-	Boiling and deep frying.
Vermicilli payasam	-	Roasting and simmering.

2.5 MICROWAVE COOKING

Microwaves are electromagnetic waves of radiant energy with wave lengths in the range of 250×10^6 to 7.5×10^9 Angstroms.

The most commonly used type of microwave generator is an electronic device called a magnetron which generates radiant energy of high frequency.

A simple microwave oven consists of a metal cabinet into which the magnetron is inserted. The cabinet is equipped with a metal fan that distributes the microwave throughout the

cabinet. Food placed in the oven is heated by microwaves from all directions.

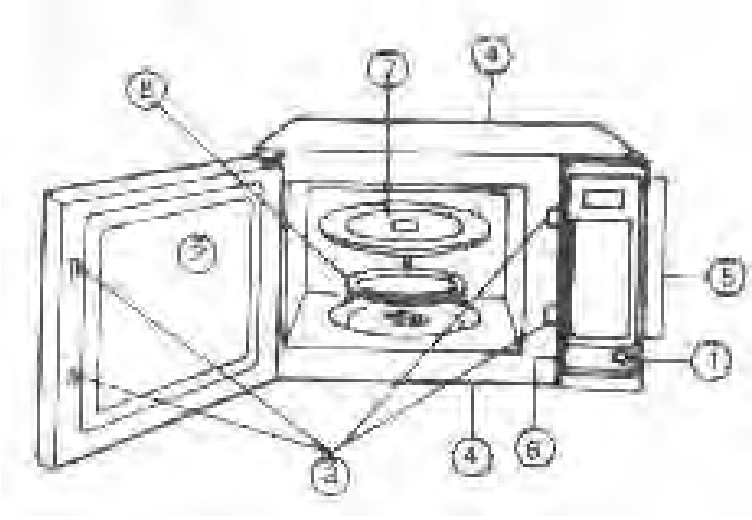


Fig. 2. 1- Microwave oven

1.Door release button 2. See –through window 3. Door safety lock system 4.External air vents 5.Control panel 6.Identification plate 7.Glass tray 8.Roller ring

Source: Srilakshmi B.(2003) Food Science , New Age International (P) Publishers Limited.Chennai.

Moist foods and liquid foods can be rapidly heated in such ovens. Food should be kept in containers made of plastic, glass or china ware which do not contain metallic substances. These containers are used because they transmit the microwaves but do not absorb or reflect them.

Merits

1. Quick method – 10 times faster than conventional method. So loss of nutrients can be minimised.
2. Only the food gets heated and the oven does not get heated.
3. Food gets cooked uniformly.

4. Leftovers can be reheated without changing the flavour and texture of the product.
5. Microwave cooking enhances the flavour of food because it cooks quickly with little or no water.

Demerits

1. Baked products do not get a brown surface.
2. Microwave cooking cannot be used for simmering, stewing or deep frying.
3. Flavour of all ingredients do not blend well as the cooking time is too short.

2.6 SOLAR COOKING

Solar cooking is a very simple technique that makes use of sunlight or solar energy which is a non-conventional source of energy.

Solar cooker consists of a well insulated box which is painted black on the inside and covered with one or more transparent covers.

The purpose of these transparent covers is to trap heat inside the solar cooker. These covers allow the radiation from the sun to come inside the box but do not allow the heat from the hot black absorbing plate to come out of the box. Because of this, temperature upto 140°C can be obtained which is adequate for cooking.

Merits

1. Simple technique – requires no special skill.
2. Cost effective as natural sunlight is the form of energy.
3. Original flavour of food is retained.
4. There is no danger of scorching or burning.
5. Loss of nutrients is minimum as only little amounts of water is used in cooking.

Demerits

1. Special equipment is needed.
2. Slow cooking process.
3. Cannot be used in the absence of sunlight – rainy season, late evening and night.

Fig. 2.2-Solar cooker

1.Solar plane mirror 2.Cooking container 3.Glass sheet
4. Cover 5. Insulation material glass 6.Outer box
7. Handle 8.Mirror support 9.Hinged adjuster and guide

Source: Srilakshmi B.(2003) Food Science , New Age International (P) Publishers Limited.Chennai.

QUESTIONS

Part- A

Fill in the blanks:

1. _____ is a method of cooking foods by just immersing then in water at 100º C
2. Simmering of food in a pan with a tight fitting lid using small quantities of liquid to cover only half the food is known as _____
3. When steam under pressure is used the method is known as _____
4. _____ is a method use to prepare cakes.
5. When food is totally immersed in hot oil, it is called _____.
6. _____ is a combined method of roasting and stewing in a pan with a tight fitting lid

Part- B

Write short answers

1. What are the objectives of cooking food?
2. Bring out the differences between stewing, steaming and sauteing.
3. What is the best method of preparing rice and dhal? Justify your choice of cooking method.
4. Write a note on solar cooking and its merits and demerits

Part- C

Write detailed answers

1. Compare the various moist heat methods of cooking. Highlight the merits and demerits of each type.
2. Give a brief account about the principles, merits and demerits of microwave cooking.
3. Explain the cooking method employed in the preparation of (a) Bread, (b) Idli, (c) Chapathis
4. Discuss the dry heat methods of cooking?

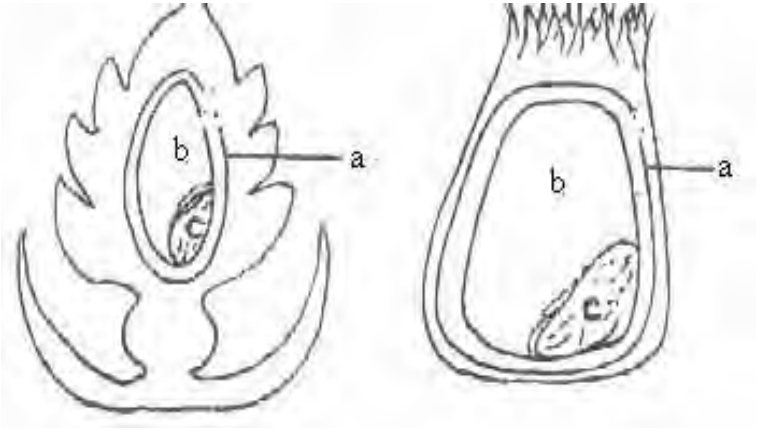
3. CEREAL AND CEREAL PRODUCTS

Cereals form the staple food of the human race. In India wheat, rice, maize (corn), oats, jowar, ragi and bajra are the common cereals and millets used.

3.1 STRUCTURE OF RICE AND WHEAT

The overall structure of all cereal grains is basically similar. Rice grains resemble wheat but is smaller than that of wheat. It is flattened laterally and has no ventral furrow.

Wheat cereal grains are composed of an outer bran coat, a germ and a starchy endosperm.



rice wheat

a. Bran b. Endosperm c. Germ

Fig. 3.1 Structural Parts of rice and wheat

Source: Sumati Mudambi, R and Shalini, M. Rao 1989 Food Science. New Age International (P) Publishers Ltd, Chennai.

The longitudinal structure of wheat grain depicting the various layers is represented diagrammatically in fig.3.2

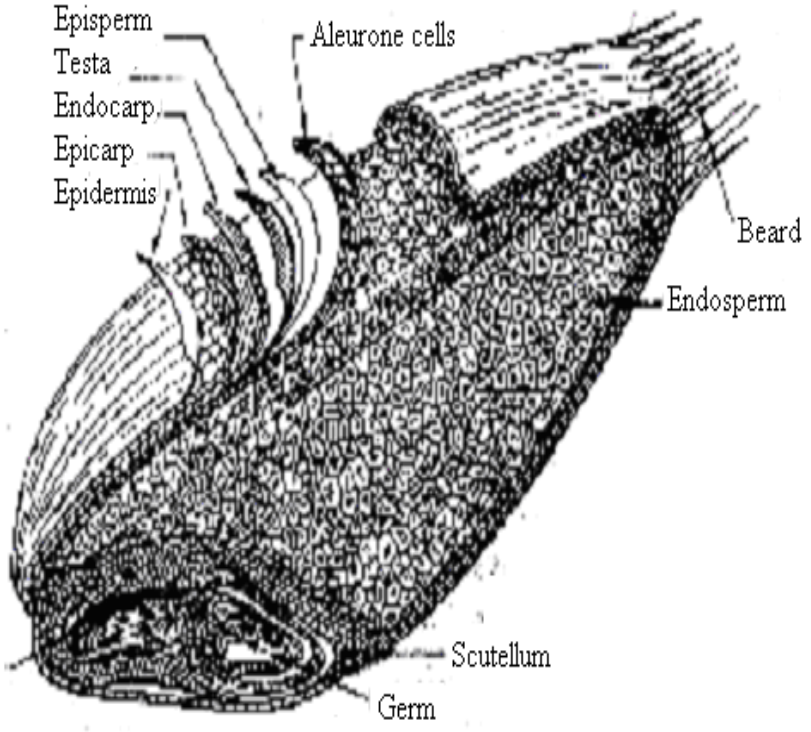


Fig. 3.2 Longitudinal structure of wheat grain

Source: Srilakshmi B. 2003 Food Science. New Age International (P) Publishers Ltd Chennai.

Bran:

Bran is the outer layer of the kernel and constitutes 5 percent of the kernel. During milling the bran is discarded. Bran is rich in fibre and minerals. It is also a good source of thiamine and riboflavin.

Aleurone Layer:

This is located just under the bran, which is rich in protein, phosphorus and thiamin and contains moderate amounts

of fat. The aleurone layer makes up about 8 percent of the whole kernel. This layer is lost in the milling process along with bran.

Endosperm:

This is the large central part of the kernel and constitutes 84 – 85 percent of the kernel. The endosperm cell consists mainly of starch and protein and little mineral matter and fibre and only half a trace of fat. The vitamin content of the endosperm is low.

Germ :

This is a small structure at the lower end of the kernel and is separated from the endosperm by the scutellum. It makes up 2 – 3 percent of the whole kernel. It is rich in protein, fat, vitamins and minerals.

The germ serves as a store of nutrients for the seed when it germinates. During milling some of the germ is lost along with the bran and aleurone layer.

3.2 NUTRITIVE VALUE OF CEREALS

Cereals are an important and economic source of energy. Hundred grams of cereals supply 340 kilo calories of energy. Cereals are also a significant source of proteins (8 – 11 percent) in the diets of people whose staple food is cereals.

However, cereal protein is incomplete as it lacks an essential amino acid, lysine. This lack is made up when cereals are eaten along with other protein foods such as dhals, pulses and milk.

Wheat flour contains glutelin and gliadin as proteins which are commonly known as gluten. The strength of the wheat flour is based on the quality of gluten used.

Whole grains chiefly furnish starch, proteins, minerals, B -Vitamins and fibre.

Refined cereals lose part of the protein, minerals, and B - Complex vitamins in milling. They contain a little more starch than whole cereals.

Whole grains contain more vitamins, minerals and fibre than refined grain and are valuable dietary sources of iron, phosphorus, thiamine and fibre.

3.3 PARBOILING AND MILLING – EFFECT ON NUTRIENT CONTENT

Parboiling is a process of soaking paddy in water at 65° - 70° C for 3 – 4 hours. The water is drained and the soaked paddy is steamed in the same vessel for 5 to 10 minutes. The paddy is dried in the sun or mechanically dried.

Advantages of Parboiling:

1. Dehusking of parboiled rice is easy.
2. Grains become tougher resulting in reduced losses during milling.
3. Part of the scutellum and germ which are rich in B – Vitamins get fixed to the grain and hence loss of B – Vitamins are less. The retention of thiamine, riboflavin, niacin and folic acid in parboiled rice is greater than that of polished or hand pounded rice.
4. It improves digestibility.
5. It swells more when cooked to desired softness.

Milling:

Milling is the process, which removes the coarse outer layer of bran and germ. Paddy is milled by hand pounding or mechanical rice millers.

The process of milling involves the following steps.

- Rice is passed through two stone or rubber discs rotating at different speeds and by shearing action on the grain, the hull is pulled away. The whole kernel from which the hulls have been removed is known as brown rice.
- This is then milled in a machine called pearler to remove coarse outer layers of bran and germ by a process of rubbing, resulting in unpolished milled rice. Some amount of breakage of rice occurs in this milling.

- Unpolished rice is liable to develop rancidity and so it is polished in a brush machine which removes the aleurone layer and yields "polished rice".
- Sometimes the polished rice is further treated in a device known as trumbol to give a coating of sugar and talc to produce a brighter shine on the grains.
- Rice is separated from the broken kernels. Large kernels are called second heads, medium ones are called screenings, smallest ones are called the brewers rice.

  The percentage loss of different nutrients during milling are

protein	15%
fat	82%
thiamine	85%
riboflavin	70%
pyridoxine (Vitamin B6)	50%.

The degree of milling determines the amount of nutrients removed.

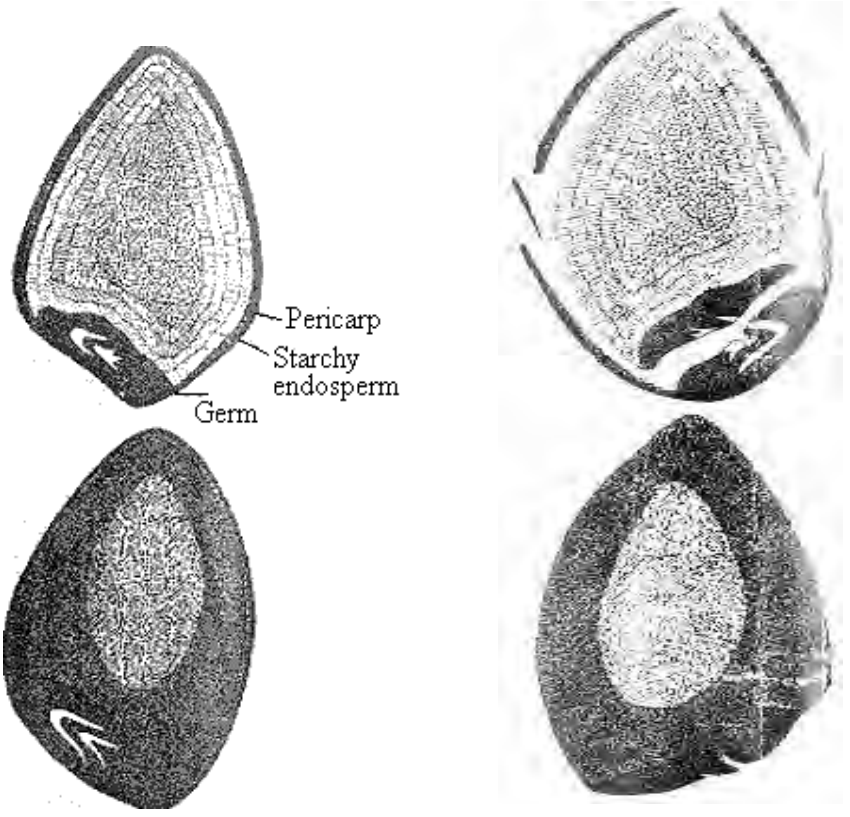
Losses during milling can be compensated by the following processes.

- By under-milling or unpolishing rice the loss of nutrients can be reduced.
- A second method is that of increasing vitamin retention by processing the rough rice prior to milling. This is done by parboiling which is commercially known as converted rice.
- Another means of remedying the losses occurring in the milling of rice is the artificial enrichment of the grain.

  A premix has been developed in which the rice is wetted with a solution of thiamin and niacin, then dried. A second coating of iron pyro phosphate is distributed on the rice.

  The rice premix is highly resistant to washing, cooking and storage losses.

(a) unmilled raw rice **(b) Milled raw rice**



(c) unmilled parboiled rice **(d) milled parboiled rice**

Fig. 3.3 – Effect of milling of raw and parboiled rice

(a) Unmilled raw rice - Germ and pericarp are intact in raw rice, Vitamin B1 and other vitamins are concentrated mainly in the germ and pericarp. When these are removed by milling, the grain has lost most of its vitamins.

(b) Milled raw rice – Germ and pericarp are removed

(c) Unmilled parboiled rice- The vitamin has diffused through the endosperm

(d) Milled parboiled rice : Although germ and pericarp have been removed, the grains still contains most of the vitamins

3.4 NUTRIENT CONTENT OF RAGI, MAIZE, AND JOWAR

Ragi :

Ragi or finger millet is widely consumed without any refining by many people in rural areas. It contains B Vitamins but is poor in thiamine. Ragi is rich in minerals especially calcium. It is also rich in fibre and is a fair source of iron.

Maize or corn :

Maize, like any other cereal is rich in calories. It is deficient in amino acid lysine. It is a good source of carotene and contains thiamine and folic acid in appreciable amounts.

Jowar :

Jowar or Sorghum is grown in Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Uttara Pradesh and parts of Tamil Nadu. It is rich in carbohydrate, and B – Complex vitamins. It is poor in vitamin – A and rich in dietary fibre. Compared to rice, jowar is richer in protein but the quality is not as good as rice protein.

3.5 MALTING OF CEREALS

Malting is a controlled germination process, which activates the enzymes of the resting grain resulting in the conversion of cereal proteins and other macromolecules. Generally barley is the grain used in the production of malt. Other grains used in the preparation of malt include wheat, jowar and ragi.

The process of malting of cereal grain consists of the following steps :

1. Selection of grain and cleaning.
2. Steeping in cold water for 36 hours with 2 to 3 changes in water.

3. Germination : The grains are spread on wire mesh trays and kept for 3 days. Water is sprinkled over each of these trays. Amylases and proteases are formed.
4. Kilning : The germinated grains are dried at slow rate on kilns. The amylases act on starch hydrolysing it to dextrin and proteases act on protein hydrolysing them to peptones.
   Amylase Rich Food (ARF) is germinated cereal flours which are extremely rich in the enzyme alpha – amylase. ARF are excellent weaning foods because they reduce the bulk of weaning foods and are energy dense.
5. Malt is used in pharmaceutical preparations, breakfast cereals, malted milk confectionaries, infant foods, bakery products, candies and in brewing.

3.6 PROCESSED CEREAL PRODUCTS

Products of wheat

Whole wheat flour:

It is obtained by grinding whole wheat. It contains the finely ground bran, germ and endosperm of the whole kernel.

Maida:

It is refined wheat flour. The bran and germ are separated in making white flour or maida. Maida bakes more uniformly into a loaf of a greater volume and it is more bland in taste and more easily digested. It is used in the manufacture of macaroni products.

Semolina:

It is coarsely ground endosperm and its chemical composition is similar to that of white flour.

Macaroni Products:

These products include macaroni, spaghetti, vermicelli and noodles.

The starchy endosperm of wheat is coarsely ground into semolina which is made with water into a thick dough. The dough is placed in a cylinder, the lower end of which is fitted with a disc perforated with openings. As the dough is forced through the openings various shapes are formed. Macaroni is a tube form, spaghetti may be either tube or rod, vermicelli is a tiny rod and noodles are flat strips.

Malted Wheat:

The process of malting helps in the production of malted cereal flour Malted cereal flour is inexpensive and can be made at home as well as commercially.

Malt is used in brewing and in the preparation of malt extract for pharmaceutical purposes and in the preparation of malted milk powder.

Broken Wheat:

Broken Wheat is whole wheat coarsely ground into large particles. As the losses during milling is little, it is a very nutritious food.

Rice products:

Rice bran:

Breakage of the white rice kernel during milling results in small fragments of the endosperm becoming part of the bran fraction. Parboiled rice bran is normally finely granulated and light tan in colour. It has a bland flavour and can be used in the preparation of bread, snacks, cookies and biscuits. In addition, rice bran is a very rich source of dietary fibre. It is therefore an effective stool bulking agent.

Rice bran oil :

Rice bran oil is obtained by extracting edible grade oil from rice bran. The National Institute of Nutrition, (NIN) Hyderabad has certified that this oil is toxicologically safe for human consumption. This oil is rich in Vitamin E. In addition, it has cholesterol lowering effect than other oils.

Puffed Rice:

Puffed rice is obtained when sun ripe paddy is filled in earthen jars and is moistened with hot water. After 2-3 minutes the water is decanted and the jars are then kept in an inverted position for 8-10 hours.

The paddy is exposed to sun for a short time and then parched in hot sand at 190 -210^{o} C for 40-45 seconds. During parching, the grains swell and burst into soft white products. The parched grains are sieved to remove sand and winnowed to separate the husk.

Rice flakes:

Rice flakes are made after soaking the paddy in hot water, parching it by roasting and then flattening it by force while it is hot to form flakes. It retains a large part of iron and B-vitamin of the aleurone layer. The roasting helps to toast the grain, resulting in partial cooking of the grain. It needs very little time to prepare and is used as a snack. It should be free from bran, broken particles, fragments of the seed coat, insects, stones, trash and bad odour.

Products of Maize

Corn oil:

Corn oil is extracted from corn germ. Corn or maize oil is a highly desired vegetable oil owing to its relatively high level of linolenic fatty acid and its excellent flavour.

Popcorn:

Popcorn is prepared by heating the kernels of corn. During heating, the water vapour within them expands, increasing the pressure until it is sufficient to make the kernels explode or "pop". It is used as a snack for children. Popping can be done with or without fat.

Corn starch:

It is made by a process of wet milling in which the hull and germ are removed. The corn is then ground and mixed with water. The semi liquid material is separated by passing it over

sieves or centrifuging it. The starch settles out while most of the protein remains suspended.

The starch is then washed, dried and powdered. Corn starch is widely used because it is inexpensive, lacks characteristic flavour and cooks to a smooth and almost clear paste in water or other clear liquid and superior to wheat flour or potato starch.

3.7 FERMENTED CEREAL PRODUCTS

The term fermentation refers to the breakdown of carbohydrate like matter under either aerobic or anaerobic conditions. The organisms involved may be bacteria or moulds. During fermentation microorganisms produce gas and help in leavening the batter or dough. They also produce flavouring substances.

Advantages of Fermentation:

1. Flavour and texture of the product is improved.
2. Vitamin B and C content is increased.
3. The product is easily digestible.
4. Acid by-products formed during fermentation inhibits the growth of harmful microorganisms.
5. Variety in the diet:- Traditional Indian recipes like idli, dosa, appam, dhokla and rice vadam are cereal based fermented products.

Idli :

Idli is a fermented and steamed food prepared using parboiled rice and black gram dhal in proportion of 3 : 1. The ingredients are ground separately, mixed together and allowed to ferment overnight. Fermentation is facilitated by bacteria such as L*actobacillus lactis, Streptococcus lactis and Leuconostoc mesenteroides.* The mucilagenious material in black gram dhal helps in the retention of carbon- dioxide during fermentation.

Dosai :

This is prepared from a fermented batter of rice and black gram (4:1). Ingredients are ground fine and salt is added and fermented overnight.

Dhokla :

It is prepared using rice and bengalgram dhal. The ingredients are soaked, ground coarsely and fermented overnight. The batter is steamed in a pie-dish and cut into desired shapes and garnished.

Appam:

It is a rice batter fermented with yeast and coconut milk or coconut water and cooked in a special appam kadai by covering with a dome shaped lid.

Rice vadam :

This is prepared by using left over cooked rice, which is soaked in excess water and allowed to ferment overnight. The water is drained and rice is mashed. Finely cut onions, chillies and lime are added and it is made into small vadam and sun-dried.

Bread :

Flour, water, milk, salt, sugar, butter and yeast are the ingredients used in the preparation of bread. All the ingredients are mixed and allowed to rise.

Fermentation is effected by the action of yeast enzyme zymase on the glucose in the dough producing alcohol and carbon dioxide. The fermented dough is kneaded by hand (knock-back) to remove gas, redistribute yeast cells, subdivide gas cells and increase the uniformity in size.

The fermented dough is then sized, shaped and placed in pans for proofing at 38° C - 48° C for 45 – 60 minutes and baked for 30 minutes at 204° C – 232° C

3.8 ADVANTAGES OF INCLUDING A COMBINATION OF CEREALS IN THE MENU

Cereals are the main source of energy in Indian diets contributing 70 – 80 percent of daily energy intake of majority of Indians. The major cereals consumed in India are rice, wheat, jowar, bajra and ragi.

Rice is the staple diet of South Indians. However, rice among the cereals is a poor source of calcium and iron. Whole wheat is a fair source of protein and fibre.

Although rice contains less protein when compared to other cereals, its protein quality is better than that of other cereals.

Ragi is rich in minerals especially calcium. Millets including ragi are rich in minerals and fibre. Inclusion of millets will help in making up deficiencies of some minerals in the diet besides providing bulk to the diet, particularly rice based ones.

The nutritive value of cereals varies with the part of the grain used. All whole cereals furnish starch, protein, iron, phosphorus, thiamin and fibre but refined cereals lose part of these nutrients during the milling process.

A judicious combination of different cereals in the days diet will help to meet the nutrient requirements.

For example wheat dosai, rice flakes payasam, ragi adai and broken wheat uppuma can be included in the menu instead of rice-based meals alone. Batters used for idli and dosai and doughs used for chappathis can be prepared using a combination of cereal flours. This will contribute different nutrients to the days diet.

3.9 ROLE OF CEREALS IN COOKERY

- Cereals form the staple diet and contribute to most of the calorie requirement and half of the protein requirement. Cereals improve the quality of pulse protein. They are excellent source of starch and B vitamins. Cereals also contribute to satiety and are used to prepare the main dish. No meal can be made without cereals.
- Cereals are used as thickening agent, e.g. corn flour in custards, corn flour in white sauce, macaroni in soups.
- Cereals are used as coating agent, e.g., maida paste in cutlets or bread crumbs in cutlets.

- Cereals are used in sweet preparations, e.g., rice, payasam, wheat halwa.
- Malted cereals are used in the preparation of beverages and weaning foods.
- Cereals products like corn flakes and rice flakes are used as ready to use foods.
- Fermented foods made from cereals are used as breakfast foods or snacks, e.g., idli, dhokla.

QUESTIONS

Part-A

Fill in the blanks:

1) _____ is the outer layer of the kernel.
2) Cereals are deficient in amino acid _____.
3) Parboiling reduces the loss of vitamins _____.
4) The process of removing bran and germ is called _____.
5) _____ is a controlled germination process which activates the enzymes of the resting grain.

Part-B

Write short answers

1) Define parboiling. Highlight its advantages.
2) What are the advantages of fermentation?
3) Discuss the advantages of including a combination of cereals in the menu.
4) Explain the roles of cereals in cookery?

Part-C

Write detailed answers

1) Discuss the nutrient content and structure of cereals.
2) Compare the nutritional significance of rice and ragi.
3) What is fermentation? What are the cereal products prepared by fermentation?
4) How is malting done? Explain the process.
5) Discuss the role of cereals in cookery. Highlight the advantage of including combination of cereals in the days menu.
6) Give a detailed account on the different types of processed cereal products?
7) How is milling done? How can nutrient losses be prevented in milling?

4. PULSES

Pulses are the edible fruits or seeds of pod-bearing leguminous plants. The term pulse in India is used for edible legumes and dhal is used for decuticled split legumes.

Bengal gram, red gram, black gram, green gram, lentil, horse gram, peas and kesari dhal are some of the major pulse crops in India. Soyabean is also grown.

4.1 NUTRIENT CONTENT OF PULSES

Pulses give 340 calories per 100 gm which is almost similar to cereal calorie. They are a rich source of protein containing about 18 – 25 percent protein. Soyabean is an exception containing about 35 to 40 percent protein.

All pulses contain sufficient amount lysine which is deficient in cereals and therefore they can supplement cereal protein. A mixture of cereals and pulses is superior to that of either one. Hence a combination of cereals and pulses is ideal for human consumption.

Pulses contain 55 – 60 percent of carbohydrate including starch soluble sugar and fibre.

They contain 1.5 percent lipids. Pulses also contain calcium, magnesium, zinc, iron, potassium and phosphorus.

They are a poor source of carotene and vitamin C but fairly rich in niacin. Germination increases the vitamin C content of pulses. The thiamine content of pulses is equal to or exceeds that of cereals. Being rich in B - Vitamins, they contribute significantly to B – Vitamin intake.

4.2 TOXIC SUBSTANCES IN PULSES

Some toxic substances are naturally present in some pulses. These include trypsin inhibitors and haemagglutinins. Trypsin

inhibitor, as the name indicates, interferes with digestion of proteins by inhibiting the action of the enzyme trypsin. Haemagglutinins combine with haeme and thus destroy haemoglobin. Fortunately, both of these toxic substances are destroyed by heat, which is used in the normal cooking process.

Broad beans contain some toxic substances. When these beans are consumed raw a disease called favism occurs. This disease is characterized by haemolytic anemia. Since human beings usually do not consume broad beans raw, they are not likely to suffer from favism.

Kesari dhal also contains a toxic substance. This dhal is grown in Madya Pradesh(M.P) It was observed that during the drought conditions, only this dhal is grown and used as a staple food. When this dhal is consumed over a long time paralysis of lower limbs occurs in males. This is known as lathyrism.

It is reported that when the intake of kesari dhal is restricted to 30 per cent of the total calorie intake, no adverse effects are observed. Therefore it is important to ensure that the intake of this dhal must be restricted to a maximum of 30 percent of the total calorie intake.

4.3 GERMINATION – NUTRIENT ENHANCEMENT

Germination is a process that involves the soaking of pulses overnight. The water is then drained and the seeds are tied in a loosely woven cotton bag and hung.

Water is sprinkled twice or thrice a day and sprouts usually appear within 6 – 8 hours.

Advantages of germination :

1. Vitamin C is synthesised during germination. The increase in vitamin C is around 7 – 20 mg per 100 gm of pulses.
2. Riboflavin, niacin, choline and biotin are increased.
3. Starch is converted into sugars.
4. It reduces the anti-nutritional and toxic factor in pulses.

5. Increased variety in the diet as sprouted pulses can be added to salads.
6. Dormant enzymes get activated and digestibility and availability of nutrients is improved.
7. Minerals like calcium, zinc and iron are released from bound form.
8. Sprouted pulses can be eaten raw, since germination improves taste and texture.

4.4 FACTORS AFFECTING PULSE COOKERY

1. Soaking in water hastens the cooking of dried pulses.
2. Soaking in boiling water reduces cooking time as the enzyme phytase present in the legume is inactivated.
3. Hard water prolongs the cooking time of dried pulses. This may be due to the reaction of calcium and magnesium ions in hard water with the pectic constituents of dried beans.
4. Addition of cooking soda (Sodium bicarbonate) will hasten cooking. However this causes loss of thiamine. Excess soda also makes cooked legumes dark and mushy.
5. Addition of acidic component such as tomato juice tamarind juice prolong the time required to make pulses tender.
6. Cooking time is considerably reduced when pulses are cooked by the use of steam under pressure.

4.5 SOYA PRODUCTS AVAILABLE IN THE MARKET AND THEIR USE

Soyabean with its high protein content is considered as a substitute for meat protein which is expensive.

Soyabean can be processed to obtain the following food products.

1. SOYA FLOUR:

Soyabean is slightly roasted and ground to yield flour. Oil is sometimes removed from the bean to give defatted soya

flour which has a higher keeping quality. Soya flour is used in combination with wheat flour in the preparation of chapathis. It can also be incorporated in the batter used in the preparation of bajji, vadai and pakoda.

2. SOYA MILK :

The milk is prepared by grinding soaked beans with water. It is then passed through a mill in a stream of water. The emulsion that is obtained is filtered and transferred to a boiler and mixed with vitaminised margarine to which sugar, salt, calcium and malt are added. The mixture is cooked for 20 minutes emulsified and then dried. The white emulsion thus expressed from soyabean has the appearance of milk.

3. SOYABEAN CURD :

Tofu or soyabean curd is prepared from soya milk. The curd is precipitated from milk emulsion by adding calcium sulphate. It is allowed to settle, and then it is separated washed and dried. It is a soft delicate structure which can be cut into pieces. It can be used like paneer in various preparations.

4. TEXTURED VEGETABLE PROTEIN (TVP) :

Textured Vegetable Protein is prepared using defatted soya flour from which most of the oil and carbohydrates are removed. The flour contains 70 percent protein and is made into dough to which colour and flavour are added. It is at times fortified with vitamins.

The dough is extruded through equipment at high temperature and pressure and the product is expanded by sudden release of pressure.

The extruded granules are marketed as TVP. It is rehydrated with water before use in the preparation of various vegetarian and non-vegetarian dishes.

5. SOYA PROTEIN ISOLATES

Soya protein isolates are protein granules, isolated by processing, It is fortified with vitamins and minerals and used as a complementary food.

Apart from these fermented soya products, soya sauce and soya paste are used in the preparation of chinese dishes.

4.6 ROLE OF PULSES IN COOKERY

- Pulses are rich in protein and B vitamins and improve the quality of cereal protein.
- Pulses give satiety due to high protein and fibre content.
- Pulses improve flavour and consistency of dhal sambar and rasam.
- They contribute to fermentation in preparation of idli and dosa.
- They are used in snacks like sundal, bajji, panipuri and bhelpuri.
- They are used in salads, e.g., sprouted gram.
- They are used in desserts like paruppu payasam and sweets like mysore pak and laddu.
- They are used as thickening agent e.g., Bengal gram flour in gravies.
- Roasted pulses are used in making chutneys and chutney powders.
- They are used as part of seasonings in curries.

Questions

Part-A

Fill in the blanks:

1) Pulses give _____ calories per 100gms.
2). Soyabean contains about _____ percent protein.
3). Pulse protein are deficient in _____ amino acids.
4). All pulses contain sufficient amount of _____which is deficient in cereals.
5). Germination increases the vitamin _____ content of pulses.

1) _____ is a process that involves the soaking of pulses overnight.

2) Addition of cooking soda causes loss of _____in pulses.

3) _____ is prepared using defatted soya flour from which most of the oil and carbohydrates is removed.

Part-B

Write short answers

1). Discuss the nutrient content of pulses.

2). Justify the nutritional significance of cereal – pulse combinations.

3). Discuss the role of pulses in cookery.

4). Write a short note on toxic substances in pulses

Part- C

Write detailed answers

1). What is germination? Explain the effect of germination on the nutrient content pulses?

2). Discuss the factors affecting the cooking quality of pulses.

3). List the products prepared from soyabean and highlight its use in Indian cookery.

5. VEGETABLES AND FRUITS

India with its diverse, but favourable agroclimatic conditions produces a wide range of tropical and temperate fruits and vegetables. The annual production of these crops is about 53 million tonnes.

Vegetables are plants or parts of plants served with the main course of a meal.

Apart from the nutritive value, vegetables probably do more than any other group of foods to add appetising colour, texture and flavour to our daily food.

With the wide choice of colour of vegetables, it is possible to select a vegetable with a desired colour to highten the appearance of a meal.

The texture of a vegetable varies depending upon whether it is served raw are cooked. The texture and appearance of meals can then be varied by the way the vegetable is served.

Vegetables contain a wide range of characteristic flavours. By a proper choice of vegetables, the desired flavour of a meal can be obtained.

A fruit is the edible and juicy product of a tree or plant and consists of the matured ovary including its seeds and adjacent parts. Usually fruits are sweet, with a wide range of flavours, colours and textures.

5.1 CLASSIFICATION OF VEGETABLES

Vegetables can be classified into three groups according to their nutritive value.

- green leafy vegetables
- roots and tubers
- other vegetables

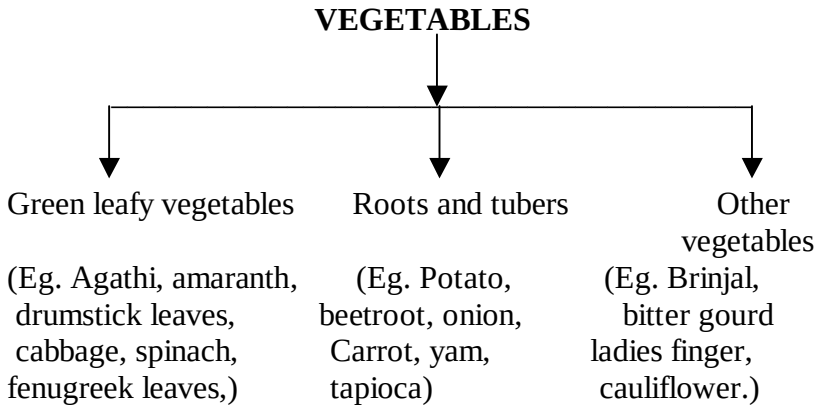


Fig.5.1 Classification of vegetables

5.2 NUTRIENT CONTENT OF VEGETABLES AND FRUITS

VEGETABLES

i. Green Leafy Vegetables :

They are an inexpensive rich source of many nutrients such as β – carotene, ascorbic acid, folic acid, calcium, iron and fibre. They are a poor source of protein.

ii. Roots and Tubers :

Roots and tubers are rich in carbohydrates and are a source of energy in the diet. Carrot and yellow varieties of yam are rich in carotene and potato contains Vitamin C. Tapioca and yam are rich in calcium. Roots and tubers are a poor source of iron, protein and a fair source of B – Vitamins.

iii. Other Vegetables :

These are a good source of dietary fibre and add variety to the diet. They are a fairly good source of vitamins and minerals. (Eg.) brinjal, ladies finger, cauliflower, cucumber, gourd varieties.

FRUITS

A fruit is a mature ovary of a flower. The fleshy portion of the pericarp makes up the chief edible portion of the fruit.

Fruits can be classified as follows :

Berries	- Gooseberry, grapes, strawberry.
Citrus	- Lemon, lime, orange, sweet lime.
Drupes	- Peach, plums, apricot.
Melons	- Water melon, musk melon
Pomes	- Apple, pear.

BERRIES :

Berries are fruits with layers of pericarp(fruit coat) which are often homogenous, except for the skin on the outside. The pericarp layers are pulpous and juicy, and contain seeds embedded in the pulp mass. The fruits have fragile cell structure that is damaged by rough handling or freezing.

CITRUS FRUITS:

These fruits belong to the genus *Citrus* which contains about 16 species of evergreen aromatic shrubs and trees mostly with thorny branches distributed throughout the tropical and subtropical regions of the world. The common citrus fruits are orange, lemon and lime. The bright colour, pleasing flavour and sweetness make them a favourite fruit. They are served as juice and can be eaten raw.

DRUPES:

Drupes are edible fruits with a thin skin, and juicy flesh enclosing a single seed (Stone). Apricots, cherries, peaches and plums belong to this group.

MELONS:

Melons belong to the same family as cucumbers (Cucurbitaceae). Melons are commonly eaten raw. Their flesh consists of about 94% water and only 5% sugars. The seeds stripped of their hard coats may be eaten and also yield an edible oil.

POMES

Pomes are fruits of apple and pear trees. The receptacle, surrounds the ovaries in the flower, enlarges to become edible and juicy, and encloses the cells containing the seeds.

Fruits particularly citrus varieties and guava are a good source of vitamin C. Yellow fruits like mango and papaya contain β– carotene. Banana is a good source of carbohydrate and hence energy. Fruits are a poor source of protein and fat with the exception of avacado.

Fruits also contain fibre and minerals such as sodium, potassium and magnesium. They are not a good source of calcium. Dry fruits, seethaphal and watermelon contribute appreciable amounts of iron.

5.3 PIGMENTS AND FLAVOUR COMPOUNDS

Chlorophyll :

Chlorophyll is the green pigment of leafy vegetables and other green coloured vegetables

Carotenoids:

Carotenoids are the yellow, orange, red fat soluble pigments distributed in nature. They are divided into three groups viz. carotenes present in carrot, green leafy vegetables and other fruits, lycopenes present in tomatoes and xanthophylls present in yellow fruits.

Pigments that contain the phenolic group include anthocyanin, anthoxanthin, leucoanthoxanthin, catechin, quinones and betalins. The first four groups are collectively known as "Flavanoids"

Anthocyanin :

They are a group of reddish water-soluble pigments occurring in many fruits and vegetables. Cherries, red apples, pomegranates have their colour appeal due to anthocyanins.

Anthoxanthins :

They are colourless white to yellow pigments that give colour to cauliflower, onions, spinach or other leafy vegetables. In green leafy vegetables the colour is masked by chlorophyll.

Leucoanthoxanthins :

They are colourless and contribute to the puckeriness or astringency of some foods, such as apple and olives. They also play an important role in the enzymatic browning of fruits.

Catechins :

They are pigments that are involved in enzymatic browning.

Betalins :

They are the red water soluble pigments found in beetroot and berries.

Quinone :

The yellow pigment juglone is a quinone present in walnut.

Mangiferin :

This is the yellow pigment belonging to the xanthone group. It is found in mangoes.

Tannins :

They are complex mixtures of polymeric polyphenols. The appearance of tannins ranges from colourless to yellow or brown. Tannins contribute to the astringency of foods and also to enzymatic browning.

Flavour Compounds :

The flavour of fruits and vegetables are extremely important to their acceptance in the diet.

The overall flavour impression is the result of the tastes perceived by the taste buds in the mouth and the aromatic compounds detected by the epithelium in the olfactory organ in the nose.

In fruits and vegetables, this means that sugars, acids, salts and bitter quinine-like compounds are tasted while the food is chewed in the mouth.

Sweetness may result from the presence of glucose, galactose, fructose, ribose, arabinose and xylose.

All fruits and vegetables contain a small amount of salt, which is detected in the overall taste impressions contributing to flavour.

The natural flavours of vegetables are due to mixtures of aldehydes, alcohol, ketones, organic acids and sulphur compounds. Some fruits and vegetables have an astringent taste attributed to phenolic compounds or tannins.

Two types of vegetables viz., vegetables belonging to the Allium and Cruciferae families have strong flavours resulting from the presence of various sulphur containing compounds. Allium is the genus that includes onions and garlic. Members of the family cruciferae, which include broccoli, cabbage, turnips and cauliflower also contain prominent sulphur compounds. They are described as strong flavoured vegetables.

Vegetables of the onion family are usually strong flavoured in the raw state and tend to lose some of the strong flavours when cooked in water.

Onions contain sulphur compounds that are acted upon by enzymes in the tissues when the vegetable is peeled or cut to eventually produce the volatile sulphur compounds that irritate the eyes and give biting and burning sensations on the tongue.

Vegetables of the cabbage family (cauliflower, cabbage, knolkhol) are relatively mild when raw but develop strong flavours when overcooked or improperly cooked.

An amino acid s-methyl l-cysteine sulphoxide is also present in raw cabbage and appears to be a precursor of cooked cabbage flavour.

5.4 PECTIN – ROLE IN GEL FORMATION

Pectin is the term designated to those water-soluble pectinic acids of varying methyl ester content. They are in between cell walls in soft tissues of most plants acting as cementing substances.

In general it is the pulp and not the juice of fruits that contain pectin. Apples contain abundant pectin in their cores and

skin. In the preparation of jams, the cores and skins are cooked with the pulp for pectin extraction. In citrus fruits, the pectin is chiefly in the white part of the rind. Other sources are sunflower seeds, guava and peels of mango and orange.

Heat is essential to extract the pectin. The usual way to extract the pectin from fruit is to heat the fruit in a small amount of water. Apples are cut into small pieces or ground with skin or core left intact and cooked to extract the maximum amount of pectin. Guavas are sliced thin and cooked with water to extract pectin.

Some points to be remembered for extracting pectin

- The maximum quantity of pectin is extracted in an acid solute. If fruits are rich in pectin but low in acidity, acidifying the solution before cooking increases the viscosity of the extraction.
- Cooked extractions contain more pectin than raw juices.
- Short periods of cooking (usually 10-20 minutes) yield extractions of better jellying power than does long boiling.

The role of pectin in gel formation

The formation of a firm jelly takes place only when pectin, acid and sugar and water are in definite proportions.

When sugar is added to the pectin solution, it acts as a dehydrating agent and destabilizes the pectin-water equilibrium and the pectin conglomerates forming a network of insoluble fibres. Large amounts of sugar solution can be held in this mesh-like structure.

The strength of the jelly depends on the structure of fibres, their continuity and rigidity. The continuity of the network depends upon the amount of pectin present in the system and the firmness depends on sugar concentration and acidity.

A soft jelly can be obtained by decreasing the amount of sugar. However, the rate of setting is modified by acidity. The

fibrils of pectin become tough in the presence of an acid and thus able to hold the sugar solution in the interfibrillar spaces. If the amount of acid is large, the fibrils lose their elasticity and as a result jelly becomes syrupy.

5.5 NEED FOR INCLUSION OF FRUITS AND VEGETABLES IN THE DAYS MENU

1. Fruits and vegetables provide vitamins and minerals required for growth and maintenance of health and are thus termed as protective foods.
2. Roots and tubers provide energy.
3. Vegetables are low in fat and can be used liberally in low calorie diets for weight reduction.
4. Besides providing nutrients they add variety to the diet. They make the diet attractive by their texture, flavour and colour.
5. Fruits and vegetables contain phytochemicals. The term phytochemicals refers to the wide variety of plant compounds naturally produced by plants. They include plant pigments and flavouring substances. Fruits and vegetables with bright colours viz., yellow, orange, red, green, blue, purple contain phytochemicals.

Beta-Carotene, Vitamin C and Vitamin E are nutrients that function as antioxidants. An antioxidant is a substance that significantly reduces or prevents oxidation of fatty acids and protein thus preventing cell and tissue damage caused by free radicals in the body.

Free radicals are unstable molecules resulting from normal metabolic processes. During these processes oxygen molecules lose an electron, which creates an unstable (molecule) thereby causing oxidative stress.

These free radicals attack healthy cells in the body in the hope of finding another electron to stabilize themselves. This process can cause damage to healthy cells.

6. Intake of fibrous fruits and vegetables are important as they :
    - give satiety and thereby decrease food intake.
    - help in regulating bowel movement.
    - low in calorie content.
    - reduce blood cholesterol levels.
    - promote chewing and decrease rate of ingestion.
7. Vegetable and fruits are used in the preparation of salads.

All vegetable have their own characteristic texture and colour. Vegetables can be grated, diced, cubed, or cut into a variety of shapes to prepare salads. The orange colour of carrots, the pale green of cabbage, the red colour of tomatoes, the green peppers and the white colour of cucumber, all indicate the variety of colours available to make attractive salads.

Vegetable used to prepare salads contribute vitamins and minerals to the diet. Vegetable salads are an important means of providing part of the need for fibre.

Fruit salad is a colourful, refreshing and light dessert. Pineapple, orange segments, apple cubes, papaya cubes, grapes, bananas, sapotas, mangoes, pomegranates are some of the fruits which can be used in a salad.

5.6 CONSERVATION OF NUTRIENTS IN PREPARATION AND COOKING OF VEGETABLES

Loss of nutrients in vegetables begin from preparation onward and is greater during the cooking process.

1. When fruits and vegetables are peeled the vitamins present under the skin may be lost.
2. Nutrients are also lost when the edible leaves of carrot beetroot and outer layer of cabbage are discarded.
3. Vitamin B complex and Vitamin C are water soluble and are lost when the water in which vegetables are cooked is discarded. Sodium, potassium and chlorine are also lost when cooking water is discarded.

4. Vitamin C is lost by oxidation due to exposure of air.
5. During dehydration ascorbic acid and carotene are lost.
6. Addition of soda results in heavy loss of B – Vitamins during cooking.

Guidelines to minimize nutrient losses during preparation:

1. Wash vegetables before cutting. Soaking or washing time should be reduced to minimize nutrient loss.
2. Cut vegetables into big pieces so that exposure of vitamins to water is less while cooking and washing.
3. Use a vegetable peeler to remove skin as it helps remove only a very thin layer of skin.
4. Use minimum water for cooking. Bring the water to boil and add the vegetables to cook.
5. Cook vegetables by steaming and pressure-cooking to conserve nutrients.
6. Cover the vessel with a lid while cooking as it hastens cooking.
7. Do not use soda while cooking vegetables as it destroys valuable vitamins.
8. Vegetables salads should be prepared just before serving to conserve nutrients.
9. Use acids such as lime juice or vinegar to salads as it prevents loss of Vitamin C since Vitamin C is stable in acid.

5.7 BROWNING

When fruits and vegetables such as apple, banana, potato and brinjal are cut, there is a development of brown colour on the surface due to action of enzymes.

This is known as enzymatic browning. When the tissue is injured or cut and the cut surface is exposed to air, phenol oxidise enzymes are released at the surface.

These act with the polyphenols present in the fruits and oxidises them to orthoquinones, which gives the brown colour to cut tissues.

Browning can be prevented by the following methods :

1. Inactivation of polyphenol oxidise by applying heat.
2. Elimination of oxygen by vacuum packing.
3. Change of pH to prevent enzyme action.
4. Dipping of fruits and vegetables in brine and sugar solutions.
5. Use of antioxidants such as ascorbic acid to retard oxidation.

QUESTIONS

Part-A

Fill in the blanks:

1). Roots and tubers are rich in _____

2). _____ is the green pigment of leafy vegetables.

3). _____ is the pigment present in carrot.

4).The pigment present in tomato is _____.

5)._____ are a group of reddish water soluble pigments occurring in many fruits and vegetables.

6). Anthoxanthins are present in _____ vegetables.

7).The pigment present in beetroot _____.

Part-B

Write short answers

1). How are vegetables and fruits classified?

2). List the major nutrients present in fruits

3). Highlight the importance of fibre rich fruits and vegetables in the diet.

4). Why does an apple become brown when it is cut?

5). What is browning? How can it be prevented?

6) Write a note on the flavour compound present in vegetable.

Part- C

Write detailed answers

1. Compare the nutrient content of green leafy vegetables roots and tubers.
2. Justify the need for inclusion of fruits and vegetables on the day' s menu.
3. How does cooking affect the nutrient content of vegetables? How can it be prevented?
4. Discuss the pigments and flavour compounds present in fruits and vegetables.

6. MILK AND MILK PRODUCTS

The story of milk goes back to the beginning of civilization itself. Cattle were domesticated even in prehistoric times and milk was one of the most essential of all foods. Milk is one of the most complete single foods available in nature for health and promotion of growth .

Milk is the normal secretion of mammary gland of mammals. Its purpose in nature is to provide good nourishment for the young of the particular species producing it. Man has learnt the art of using milk and milk products as a food for his well being and has increased the milk producing function of the animals best adapted as a source of milk for him.

The cow is the principle source of milk for human consumption in many part of the world; Other animals as source of milk for human beings are the buffalo, goat, sheep, camel and mare. In India, more milk is obtained from the buffalo than the cow. Some amount of goat milk is also consumed.

6.1 NUTRITIVE VALUE OF MILK

Milk is a complex fluid containing protein, fat, carbohydrate, vitamins and minrals. The main protein in milk is casein and it constitutes 3.0 - 3.5 percent of milk.

The fat content of milk varies from 3.5 percent in cow's milk to about 8.0 percent in buffalo's milk. Fat is present in the form of fine globules varying in diameter from 1 to 10 μm (micrometers).Milk also contains phospholipids and cholesterol.

Lactose is the sugar present in milk. The important minerals in milk are calcium, phosphorus, sodium and potassium. Milk is an excellent source of riboflavin and a good source of Vitamin A. However, milk is a poor source of iron and ascorbic acid. The small amount of iron present is bio available.

6.2 TYPES OF PROCESSED MILK

Raw milk is processed into the following types of milk.

1. Skim Milk:

Skim milk is whole milk from which fat has been removed by a cream separator. The quantity of fat is usually 0.05 to 0.1 percent. It contains all other milk nutrients, except Vitamin A and D, but can be fortified by the addition of these vitamins.

2. Toned Milk :

Toned milk is prepared by using milk reconstituted from skim milk powder. Skimmed milk is prepared by removing fat from milk in a cream separator.

The skimmed milk is then mechanically dried to give skim milk powder. It is mixed with buffalo milk containing 7 percent fat. The fat content of toned milk should be less than 3 percent.

3. Standardised Milk:

In standardised milk the fat content is maintained at 4.5 percent and soluble non-fat is 8.5 percent. It is prepared from a mixture of buffalo milk and skim milk.

4. Homogenised Milk:

Homogenisation is a mechanical process that reduces the size of fat globules by forcing milk through small apertures under pressure and velocity.

When milk is homogenised, the average size of the globule will be 2 micrometers. The decrease in the size of fat globules increases their number and surface area.

The newly formed fat droplets brings about stabilisation of the milk emulsion and thus prevents rising of the cream. Homogenised milk has a creamier texture, bland flavour and whiter appearance.

5. Evaporated Milk:

It is made by evaporating more than half the water from milk under vacuum, at a temperature of 74° C - 77° C. It is then fortified with vitamin D, homogenised and filled into cans

and sterilized at a temperature of 118° C for 15 minutes and cooled. The treatment employed lends a brown colour and characteristic flavour owing to the reaction between sugar and protein.

6. Condensed Milk:

It is obtained when whole milk is concentrated to about one-third of its original volume and has about 15 percent sugar added to it. The preparation of condensed milk involves (i) filtration and pasteurization of milk, (ii) preheating and evaporation, (iii) addition of sterilised sugar syrup, (iv) homogenisation.

7. Flavoured Milk :

It is the milk prepared by the addition of flavour such as rose, pista, badam, cardamom etc. to pasteurised whole milk.

8. Milk Powder:

Milk powder is prepared by dehydrating whole milk in drum driers or spray driers. In the case of drum or roller drying, the milk is filtered, pasteurized, homogenised and then fed into roller driers which are internally heated with steam.

The dried milk is obtained as a thin sheet and is powdered. In spray drying, the homogenised milk is blown as a fine spray into a pre-heated vacuum chamber resulting in fine dry powder. The milk powder is collected, cooled and packed.

6.3 PHYSICAL PROPERTIES OF MILK

Acidity :

Milk has a pH of about 6.5 to 6.7. The salts of the minerals – calcium, phosphorus, sodium and potassium help to maintain this pH level.

Viscosity :

The viscosity of milk is affected by temperature, amount and nature of dispersion of protein and fat, acidity and the effects of various enzymes and bacteria. Homogenization increases the viscosity of milk.

Freezing Point :

The freezing point of milk is –0.55° C.

Boiling Point :

Milk boils at 100.2° C.

6.4 PASTEURISATION OF MILK

Milk is a favourable medium for bacterial growth. Pasteurisation destroys all pathogenic bacteria, including those causing typhoid, tuberculosis, diphtheria as well as yeasts and moulds.

Pasteurization is a process which consists of heating milk to a certain temperature for a definite time to ensure destruction of harmful bacteria. There are three methods of pasteurisation.

a) **Holding method or Batch process :**

In this method, milk is held at 62.8° C for 30 minutes and then rapidly cooled to prevent multiplication of surviving bacteria.

b) **High temperature short time (HTST) method or continuous process :**

Milk is heated to 71.7° C for not less than 15 seconds.

c) **Ultra High temperature method :**

Milk is heated to a temperature of 93.4° C for 3 seconds.

Advantages of Pasteurization

- During pasteurization the nutritive value of milk is not altered to a great extent because the temperature employed is not high and cooking time is short. However, there is a slight decrease in heat labile vitamin such as thiamine and ascorbic acid. Proteins are denatured only slightly and minerals are not appreciably precipitated.
- It does not produce an unpleasant cooked flavour.
- Shelf life of milk is increased due to a marked decrease in the total bacterial count.
- Harmful pathogens especially TB bacteria are destroyed.

- It inactivates enzymes such as phosphatase and lipase in milk which adversely affect the quality of milk.

6.5 MILK PRODUCTS

Khoa:

Khoa is prepared by evaporating whole milk in an open cast iron pan with continuous stirring until it is semi-solid. It is used extensively in the preparation of Indian sweets.

Cream :

Cream is the fat of milk and is used in the preparation of sweets. It is made by simmering large quantities of milk until a thick layer of milk fat and coagulated protein form on the surface. It can be consumed with or without the addition of sugar.

Butter :

Butter is obtained from cream by churning. When cream is churned, the fat globules are destabilised and coalesce until the milk separates into two phases – viz., the butter and the aqueous phase. Butter is removed and washed.

Butter is used as a cooking medium in many Indian recipes. It is one of the main ingredients in cakes, biscuits, icing and bread.

Ghee :

Ghee is butter oil. It is prepared by melting butter and separating the moisture from butter by heating. It is used in preparing Indian sweets, savouries, curries and variety rice like pulav and biriyani.

Paneer :

Paneer is a soft cheese prepared by addition of lemon juice or citric acid to hot milk and precipitating the casein. The liquid released in this process is known as whey and the resultant curd is tied in a muslin cloth and hung for a day to squeeze any liquid present in it. The soft cheese (paneer) that is obtained is used in Indian gravies and pulavs. It is a very good source of protein.

Cheese :

It involves the curdling of milk with enzyme rennet under microbially controlled condition. Milk is held at about 27° C in vats and a lactic acid culture is added. When the milk gets acidic, rennet is added to it and the milk is allowed to coagulate.

The curd formed is cut and heated to about 37° C with constant stirring to remove the whey. The whey is drained. Salt is mixed with the curd and it is pressed to remove further amount of whey.

The cheese formed is coated with paraffin to prevent loss of moisture. The paraffined cheese is allowed to ripen for three to six months at temperatures between 45° to 60° C. Cheese is a concentrated source of protein.

Curd :

Curd is prepared by heating milk to about 50° C. A teaspoon of curd (starter) from an earlier batch of curd is added and is mixed thoroughly. The lactic acid bacteria present in the starter curdles the milk. The bacteria breaks down lactose to lactic acid thereby increasing the acidity of milk. When the pH reaches 4.6, the milk protein casein coagulates as curd.

The optimum temperature for the formation of curd is 35° - 40° C and the time needed for curd formation is 8 – 12 hours depending on the atmospheric temperature. Curd is used as a dressing on salads made from fresh vegetables and combines well with plain cooked rice.

Yoghurt :

This is a coagulated milk product with curd like consistency. It is made from partially skimmed or whole milk and it has a slightly acidic flavour.

In the production of yoghurt, a mixed culture of *Lactobacillus bulgaricus, Streptococcus thermophilus and Lactobacillus acidophilus* is added to pasteurised milk and incubated at 42° C to 46° C.

6.6 ROLE OF MILK AND MILK PRODUCTS IN COOKERY

- It contributes to the nutritive value of the diet, e.g., milk shakes, plain milk, flavoured milk, cheese toast.
- Milk adds taste and flavour to the product e.g., payasam, tea, coffee.
- It acts as a thickening agent along with starch e.g., white sauce or cream soups.
- Milk is also used in desserts, e.g., ice-cream, puddings
- Curd or buttermilk is used as a leavening agent and to improve the texture, e.g., dhokla.
- Curd is used as a marinating agent, e.g., marinating chicken and meat.
- Curd is used as a souring agent, e.g., rava dosa, dry curd chillies.
- Khoa is used as a binding agent, e.g., carrot halwa.
- Cheese is used as garnishing agent.
- Salted butter milk is used for quenching thirst.

QUESTIONS

Part-A

Fill in the blanks:

1). The main protein present in milk is known as _____

2). _____ is the sugar present in milk.

3). The fat content of toned milk is _____ percent.

4). The process of breaking fat globules is known as _____.

5). The pH of milk is _____.

6). The boiling point of milk is _____ and its freezing point is _____.

7).When fat is removed from whole milk, the resultant product

is known as _____.

8) _____ is prepared by evaporating whole milk in an open cast iron pan.

9). _____ is obtained by melting butter.

10) .In the preparation of cheese, milk is curdled using _____.

Part-B

Write short answers:

1).What are the nutrients present in milk?

2).Differentiate toned milk and homogenised milk.

3).Write a brief note on the physical properties of milk.

4).Write a short note on homogenisation. Highlight its advantages.

Part- C

Write detailed answers:

1). Why is pasteurization and homogenization carried out in milk? Highlight its advantages.

2). Give a detailed account on the various milk products prepared from milk.

3). Discuss the role of milk and milk product in cookery.

7. FLESH FOODS AND EGG

7.1 NUTRITIVE VALUE AND SELECTION CRITERIA OF MEAT, POULTRY, EGG AND FISH

Meat :

Meat refers to the flesh of warm blooded, four legged animals chiefly cattle, sheep and pigs. Meat of sheep which is under 12 months age is sold as lamb. After the age of 12months, it is called mutton.

Pork is the meat of swine (pig) slaughtered between the age 5 and 12 months. Veal is the meat of cattle that is slaughtered 3 to 14 weeks after birth.

If slaughtered between 14 to 52 weeks the meat is called calf. Meat obtained from cattle slaughtered one year after birth is called beef.

Meat is a very good source of protein. The average protein content of meat varies from 16 – 25 percent. The amino acid pattern of meat protein is of outstanding nutritive value. The fat content of meat varies from 5 – 40 percent.

Depending on the type, breed and age of the animal, fat is distributed throughout meat in small particles of large masses. Fat deposited uniformly in small sheets in the connective tissue within the muscle is called “marbling”. This contributes tenderness and flavour to the meat.

Meat fats are rich in saturated fatty acids. The cholesterol content of meat is 75 mg / 100 gm. Carbohydrate is found in small quantities and present in the form of glycogen and glucose.

Meat is a good source of iron, zinc and phosphorpus. It also contains sodium and potassium. It is an excellent source of B-complex vitamin particularly B_{12} which is absent in plant foods. Liver is an excellent source of iron and vitamin-A.

Changes in Meat :

After slaughtering, the lean tissues undergo a series of complex physical and chemical changes. As a result muscles loose their soft pliable nature and become rigid, stiff and inflexible. This is termed as "rigor mortis".

Stiff muscle starts to soften and becomes tender when it is held in a cold room temperature between 0°C to 20°C for 1 – 4 weeks. This is known as "ripening" or "ageing".

During ageing the humidity of the room is to be controlled. Tenderness of meat can also be obtained by the use of mechanical methods such as pounding, cutting and grinding which break muscle fibre. Addition of salt, vinegar, lime juice and enzymes viz., papain, bromelin and ficin also help in tenderising meat.

Changes that occur during cooking:

- On heating, the red pigment turns brown due to the denaturation of protein pigment.
- Heat treatment also brings about inactivation of enzymes and denaturation of proteins, which makes meat tougher. Hence, adopting correct cooking methods, time and temperature will result in a well-cooked product.
- Heating results in release of volatile compounds from both fat and lean meat which contributes to the flavour and taste of cooked meat.
- Heating melts meat fat which increases palatability of meat when eaten warm.
- There is loss of water on heating which does not change the nutritive value but may affect juiciness and bring about shrinkage in volume and weight.
- Minerals like calcium may be lost in meat dripping due to the dissolution of calcium from bones. There is loss of B-vitamins also.

Poultry:

The term poultry refers to domestic fowls reared for their flesh and egg. It includes chicken, duck, geese, turkey, pigeon etc.

Poultry meat has a high protein content varying from 18 to 25 percent. It contains all the essential amino acids required for body building.

Fat content of poultry is influenced by age and species of the bird. Young birds have little fat content. Chicken fat is unsaturated and is therefore better than the fat of red meat. Poultry flesh is a good source of B-vitamin and minerals.

Egg :

The term egg mainly refers to the egg of hen and duck. An average egg weighs 50 gms. approximately and is composed of the shell, egg white and yolk. The weight is distributed in the different parts as follows.

TABLE – 7 A

Percentage composition of egg

Part	Weight%
Shell	8 – 11
White	55 – 61
Yolk	27 - 32

Egg is a rich source of protein and lipids. Egg protein is of high quality as compared to any dietary protein and therefore is used as a standard for evaluating the protein quality of other foods. The nutrient composition of egg white and yolk differ considerably and is represented in the following table.

TABLE – 7 B

Percentage nutrient composition of egg white and yolk

Nutrient	Egg white	Egg yolk
Water	88.0 %	48.0 %
Protein	11.0 %	17.5 %
Fat	0.2 %	22.5 %
Mineral	0.8 %	2.0 %

Vitamin and minerals in Egg:

Egg yolk is rich in vitamin-A. Thiamin and riboflavin are present in appreciable amounts. Calcium is present in the yolk in small amounts.

Phosphorus is abundant in the yolk. Eggs are an important source of bioavailable iron and a fair source of sodium, magnesium chlorine, potassium and sulphur.

Fish:

Fishes are classified as shell fish and fin fish. The nutrient composition of fish of a given species varies depending on the season of year and maturity. However most fish contain 15 – 24 percent protein, 0.1 – 22 percent fat and 0.8 – 2 percent minerals.

Fish proteins are easily digestable and are of high biological value. The fat content is influenced by the species, feeding habits and maturity of fish. Glycogen is present in fish but is in lesser quantities than meat.

Fish oils are an excellent source of vitamin A and D. They are a good source of thiamin, riboflavin and niacin. Small fishes that can be eaten with bones contribute a significant amount of calcium.

Ocean fish are a rich source of iodine. Oysters are an excellent source of copper. Fishes contain omega – 3 polyunsaturated fatty acids. These acids are found to prevent the degeneration diseases of the heart.

SELECTION CRITERIA:

Meat:

Veal or the meat of calf is pale pink and firm. The meat is soft and flabby and the cut surface is moist. The bone is pinkish white with a small quantity of blood. Fat is not seen.

In the case of lamb, flesh of young animals below 12 months of age, the meat is pinkish red, fine grained and velvetty. The bones are porous and reddish. Good quality mutton is deep red in colour with a smooth covering of fat. The bone is hard and white.

Poor quality meats have darker flesh and the grain is coarse and fibrous. Fat layers are heavy and have a strong flavour.

Poultry :

Young birds (below 9 months of age) have a tender flesh and are more suitable for cooking.

Signs of a young bird :

- The feathers especially the quills on the wings should be easy to pull.
- No long hair on the body.
- Skin should be white or clean and smooth.
- Feet should be supple with smooth even over-lapping scales.

Signs which show that a bird is fresh :

- Feathers – light and fluffy.
- Eyes – prominent and clean
- No unpleasant smell
- Feet moist and not stiff and dry.
- Skin – clear with no dark or greenish tinge.

Egg:

- The shell should be clean and should not be broken.
- Fresh eggs have a small air cell. This can be detected by holding the egg against light.
- Yolk should be in the centre without any dark spots when observed against light.
- Good quality egg will sink when immersed in water. Poor quality eggs will float due to the enlarged air cell and loss of moisture.

Fish:

The following points should be borne in mind while selecting fish :

i) Eyes should be bright and not sunken.

ii) Gills should be red.

iii) The tail should be stiff and scales firmly attached to the skin.
iv) The flesh should be firm and not flabby.
v) There should be no unpleasant odour.
vi) To test a cut piece, press down with a finger and if an impression is left then the fish is stale.
vii) Any tendency for the raw flesh to come away from the bone is a dangerous sign.

7.2 USE OF EGG IN COOKERY

As a Thickening Agent :

Egg proteins coagulate on heating. The coagulation of protein is accompanied by binding of moisture and increase in viscosity. Therefore eggs can be used as thickening agents.

As a Binding Agent :

Egg protein coagulate between 65 and 70° C and help to hold shape of the products such as cutlets in which it is used.

As a Leavening Agent :

Eggs when beaten, form elastic films which can trap air. This air expands during baking and gives a fluffy spongy product.

As a Emulsifying Agent :

Besides protein, egg contains phospholids such as lecithin which are known for their emulsifying quality. Hence egg can be used an excellent emulsifying agent in products such as mayonnaise as it is able to stabilise the oil in water dispersion.

As a Flavouring and Colouring Agent :

Egg is used in food mixtures to contribute flavour and colour to products such as cakes and pudding

As a Clarifying Agent:

Egg helps in the preparation of clear soups. When a small amount of egg white is added to the liquid and heated, the

egg albumin coagulates and carries along with it suspended particles. On allowing it to settle, a clear soup is obtained.

As a Garnishing Agent :

Hard boiled eggs are diced and are used to garnish dishes like biryani.

As an Enriching Agent :

Eggs are used to enhance the nutritive value of various preparations.

QUESTIONS

Part-A

Fill in the blanks:

1). The protein content of meat varies from _____ to _____ percent.
2). Liver is a rich source of vitamin _____.
3). _____ present in fishes helps to prevent degenerative diseases of the heart.
4). The colour of good quality mutton is _____.
5). Fresh eggs should _____ when immersed in water.
6). Yolk should be in the _____ when observed against light.

Part-B

Write short answers:

1). What are the changes that occur in meat after slaughtering?
2). Compare the nutritive value of egg white and egg yolk.

Part- C

Write detailed answers:

1). Discuss the nutrient content of meat, poultry, and fish.
2). What are the factors to be considered while selecting:
   a) Fish
   b) Poultry
   c) Meat
   d) Egg
3. Highlight the nutrient content of egg. Give a detailed account on the uses of egg in cookery.

8. NUTS AND OIL SEEDS

8.1 NUTRITIVE VALUE OF NUTS

Nuts are a rich source of protein and fat and a good source of B – Vitamin and antioxidant vitamin E. They are a concentrated source of energy.

Groundnut, cashewnut, coconut and almonds are the nuts commoly used in India and their nutritive value is given in table 8A

- Groundnuts are a very rich source of protein and fat. They are exceptionally rich in niacin. Groundnuts are boiled or roasted and consumed.

  It is also used in the preparation of groundnut butter. The chief product is the oil which can be used for cooking. The cake left after the oil is extracted is purified and used in supplementary mixes.
- Cashewnuts are also a rich source of protein and fat and contain appreciable amount of iron. It is widely used in the preparation of sweets and confectionery.

  It can be roasted and eaten. Cashewnuts are also used to garnish dishes such as pulavs and payasam.
- The white flesh of coconut is rich in calories though not a very good source of protein. It is extensively used in cookery in Tamil Nadu and Kerala in the preparation of curries, chutneys, sweets and puddings.

  The white flesh when dried is called copra and has a high content of oil.
- Almonds are expensive and are used in the preparation of badam milk and sweets. It is a rich source of protein that are not of high biological value.

  Almonds are an excellent source of vitamin E, an antioxidant.

TABLE 8 A
Nutritive value of nuts per 100 gm.

Nuts	Energy	Protein	Fat	Carbohydrate	Calcium	Iron	Thiamine	Riboflavin	Niacin
	kcal	g	g	g	mg	mg	mg	mg	mg
Groundnut	567	25.3	40.1	26.1	90	2.5	0.90	0.13	19.9
Cashewnut	596	21.2	46.9	22.3	50	5.8	0.63	0.19	1.2
Coconut fresh	444	4.5	41.6	13.0	10	1.7	0.05	0.10	0.8
Almond	655	20.8	58.9	10.5	230	5.1	0.24	0.57	4.4

8.2 OIL SEEDS

Groundnut :

Groundnut oil which is obtained from groundnut is a clear amber coloured liquid which is extensively used in cooking. It is used in the preparation of margarine, vanaspathi and preservation of sardine fish.

The residue left after the oil extraction of groundnut is the groundnut cake, which is used in the preparation of groundnut flour and cattle feed for farm animals.

Coconut :

Coconut oil is extracted from dried coconut. It can also be used in the preparation of vanaspathi and margarine. Coconut cake obtained after oil extraction is a valuable feed for cattle.

Soyabean :

Soyabean yields substantial amount of oil. The whole dry beans contain 40 percent protein and 20 percent fat. In India, soyabean oil finds its application in the manufacture of vanaspathi.

The meal after oil extraction is being used widely as a poultry feed. The protein isolated from soyabean meal after oil extraction is being successfully incorporated in weaning and supplementary foods.

Sesame seeds :

Gingelly oil is extracted from sesame seed and it is a traditional oil that has been used in India. The roasted seeds are mixed with jaggery syrup and made into balls and eaten.

Decorticated seeds contain 25 percent oil and are used for oil extraction. Sesame seeds are a fair source of protein and calcium.

8.3 ROLE OF NUTS IN COOKERY

Nuts and oilseeds are used in cookery as whole, halved, ground or desiccated.

- Nuts are used in fresh, raw, roasted, boiled or salted forms and also fried forms.
- Nuts are used as thickening agents. Coconut and cashewnuts are used as thickening agents in the preparation of gravy.
- Chutneys can be made and used from nuts, e.g., groundnut and coconut.
- Sweets can be made from nuts, e.g., cashewnut and coconut burfi.
- Powders made out of nuts like groundnut and coconut are used as chutneys and salad dressing.
- Nuts are used to garnish ice-creams and cakes
- Nuts are used in beverages, e.g, badam kheer.
- Peanut butter is used as a topping on bread or as side dish along with chapathis.

QUESTIONS

Part-A

Fill in the blanks:

1). Nuts are a rich source of _____ and _____
2). Groundnuts contain _____ gram of protein.
3). The iron content of cashewnut is _____ gram
4). The protein content of almond is _____gram.
5). Groundnuts are exceptionally rich in vitamin _____

Part B

Write short answers

1). Compare the nutritive value of groundnut and coconut.
2). Write a brief note on sesame seeds and groundnut.

Part- C

Write detailed answers

1). Give a detailed account on the nutritional; significance and use of nuts and oil seeds.

9. FATS AND OILS

Fats are an important component of the diet and is present naturally in many foods. Fats are solid at room temperature while oils are liquid. Fats in the diet can be of two kinds viz., the visible and the invisible fat.

Invisible fats are those present inherently in foods. Example of food containing appreciable quantities of invisible fat include meat, poultry, fish, dairy products, eggs, nuts and seeds.

Visible fats are those fats that are made from these products. They are cooking oils, salad oils, butter, ghee and margarine.

9.1 NUTRITIONAL SIGNIFICANCE

- They are a concentrated source of energy. One gram of fat contributes 9 kilocalories as against 4 kilocalories contributed by carbohydrates and protein.
- They are a good source of vitamin A,D,E and K.
- They provide essential fatty acids which are components of membranes of living cells.
- They impart special flavour and texture to our foods, thus increasing palatability.
- They are also used by the body to make prostoglandins involved in a large variety of vital physiological functions.

9.2 REFINED OILS

Oils and fats do not occur free in nature. They occur in animal tissues and in seeds and fruits from which they are isolated.

The extracted oils are crude and contain many constituents like free fatty acids, unsaponifiable matter, gums, waxes, mucilaginous matter, variety of colouring matter,

metallic contaminants and undesirable odour producing constituents. In refining these constituents are removed by the following steps:

- Suspended particles are removed by filtration or centrifugation.
- Free fatty acids are removed by alkali treatment.
- Any remaining free fatty acids are removed by neutralisation.
- Pigments are removed by bleaching using adsorbents like activated earth or carbon and sometimes chemical bleaching agents.
- The oil is finally deodorized by injecting steam through the heated fat under reduced pressure to obtain refined oil.

9.3 HYDROGENATION – VANASPATHI AND MARGARINE

Plant oils contain a large percentage of unsaturated fatty acids and hence have a tendency to become rancid. These unsaturated glycerides in oil can be converted to more saturated glycerides by the addition of hydrogen. This process is known as hydrogenation.

Hydrogenated fat is manufactured from vegetable oils by the addition of molecular hydrogen to the double bonds in the unsaturated fatty acids in the presence of nickel.

The double bonds take up hydrogen and saturated fatty acids are obtained. By this process, liquid fats can be converted to semi solid and solid fats for use as shortening in the preparation of biscuits, cakes and butter substitutes.

Hydrogenation is of great economic importance because it allows oils to be converted into fats, which have better keeping quality.

As hydrogenated fats are prepared from refined deodourised oils, the resulting fats are odourless and colourless and blend well in several food preparations.

Vanaspathi:

Hydrogenated oil in India is known as vanaspathi. It is manufactured by hydrogenating refined groundnut oil or a mixture of groundnut oil with other edible vegetable oils.

According to vanaspathi control order, the melting point of vanaspathi should be between 31°C and 37° C and it should contain 5 percent sesame oil and should be fortified with vitamin A.

Margarine :

Margarine is often used as a substitute for butter. It is made from vegetable oils or a mixture of vegetable and animal fat by hydrogenation.

It is then blended with cultured skim milk and salt. The fats most commonly used in the manufacture of margarine are cotton seed oil, soyabean oil, corn oil, groundnut oil, coconut oil and meat fat.

Additional additives may include diacetyl for butter flavour, sodium benzoate for preservation, mono and diglycerides or lecithin for emulsification, yellow colouring matter and vitamin A and D.

9.4 RANCIDITY

Fats and oils undergo certain undesirable changes during storage which result in spoilage. The major spoilage of fats and oils is rancidity.

Rancidity refers to the development of disagreeable odour and flavour in fats and oils owing to specified chemical reaction such as oxidation and hydrolysis.

Hydrolysis is the decomposition of fats into free fatty acid and glycerol by enzymes in the presence of moisture. These free fatty acids released are responsible for the unpleasant flavour and odour.

During oxidation, oxygen is added to the unsaturated linkage and this results in the formation of peroxides. These peroxides decompose to yield aldehyde and ketones which are

responsible for the pronounced off flavour. Rancidity may also be caused by the absorption of odour and action of micro organism and enzymes.

Prevention of rancidity :

- Storage in coloured glass containers prevent oxidation of fats by rays of light.
- Vacuum packaging retards rancidity by excluding oxygen.
- Naturally occurring antioxidants like vitamin C, β carotene and vitamin E protect against rancidity.
- Synthetic antioxidants like butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT) and propylgallate can also be added to prevent rancidity.

9.5 SMOKING POINT

When fats and oils are heated to a high temperature, decomposition of fat occur and finally a point is reached at which visible fumes are given off. This is called smoking point and the temperature is called smoking temperatures of fat.

Smoking temperature is defined as the lowest temperature at which visible fumes consisting of volatile gaseous products of decomposition are evolved.

Factors affecting smoking temperature of fats and oils :

1. The amount of free fatty acids present.
2. The surface of oil exposed while heating.
3. The presence of mono and diglycerides and foreign particles such as flour particles.

Smoking temperature is important for fats used for frying. Fats with low smoke point are not suitable for frying because of the odour and irritating effect of the fumes.

The decomposition products may also give an unpleasant flavour to the food. Hence it is preferable to use fats with relatively high smoking temperatures for frying.

The smoking points of some fats and oils are given below :

TABLE – 9 A
Smoking points of some fats and oils

Oil or fat	Smoking temperature (° C)
Soyabean oil	230
Hydrogenated fat	221
Butter fat	208
Groundnut oil	162
Coconut oil	138

9.6 ROLE OF FAT / OIL IN COOKERY

- Fat is used as a medium of cooking in shallow and deep fat frying.
- Fat improves the texture of food. e.g., cake, biscuit, cookies.
- Fats help in leavening – in making cake, leavening occurs by incorporating air into the fat during the leavening process.
- Fat increases smoothness of the product e.g., Halwas, crystalline candies.
- Fats are shortening agents- one of the most important function of fat is to shorten baked products which otherwise are solid masses firmly held together by strands of gluten.
- Fat improves palatability – fat gives taste and flavour to the food.

QUESTIONS

Part-A

Fill in the blanks

1). Fats contribute _____ kilocalories per 100 gm.
2). In hydrogenation _____ fatty acids are converted to _____ fatty acids by the addition of hydrogen.
3) Hydrogenated oil in India is known as _____.
4). _____ is a good substitute for butter.
5). The development of disagreeable flavours and odours in fat is known as _____.
6). Fats with _____ smoking point are suitable for frying.

Part-B

Write short answers

1).What are visible and invisible fats? Discuss the role of fats in cookery
2). Explain the following terms
(a) hydrogenation, (b) randicity
3). How do fats and oils become rancid? How can it be prevented?
4) Discuss the role of fats in cooking

Part- C

Write detailed answers

1). Discuss the nutritional significance of fats and oils. Explain the role in cookery
2). Explain the following
(a) refined oils (b) Hydrogenation (c) Rancidity.
3). Define smoking point. Give the smoking points of some fats and oils and justify your choice of oil for deep-frying food.

10. SPICES AND CONDIMENTS

Spices and condiments are indispensable components of Indian cuisines. These are accessory foods mainly used for flavouring food preparation to improve their palatability.

These are used in small amounts and their contribution to nutrient intake is very limited. Some of the spices are rich in iron, trace metals and potassium.

Some condiments like chillies and coriander are a fair source of β - carotene. Green chillies provide β - carotene and vitamin – C.

Spices are aromatic plant products used to season food. Condiments are seasonings added to the food at the table, eg. salt. However, there is no clear cut division between the two.

10.1 SPICES AND CONDIMENTS IN INDIAN COOKERY

The common spices and condiments used in Indian cookery is discussed in the following table.

TABLE –10.A

Spices and Condiments in Indian Cookery

Sl No	Spices	Usage
1.	Ajwain (omum)	Used in curries, pickles, biscuits, beverages, confectionery due to its characteristic aroma and pungent taste. **Medicinal use :** Antispasmodic, stimulant used for treating digestive disorders.

2.	Aniseed (somfu)	Used for flavouring curries, cakes, cookies, biscuits. It is served fresh and coated with sugar syrup as a mouth freshner at the end of an Indian meal. **Medicinal use :** Counteracts flatulence, used in treating colic pain.
3.	Asafoetida	Used in seasoning rasam, sambhar, lemon rice and for flavouring curries, sauces and pickles. **Medicinal use :** Used in treating bronchitis and whooping cough. It counteracts intestinal flatulence.
4.	Bay leaves (Birinji leaves)	Used for flavouring vinegar and seasoning biriyani, pulav, soup, meat preparation.
5.	Cardamom (Elaichi)	Used for flavouring curries, cakes, sweets, beverages and bread. **Medicinal use :** Appetiser and effective remedy for indigestion and urinary disorders.
6.	Coriander seeds (dhania)	Flavouring in pickles, sausges, seasoning and confectionery. **Medicinal use :** Used in flatulence, vomiting and intestinal disorders, recommended in hypertension.
7.	Chillies	Essential ingredient in Indian curries. Used in making chutneys, pickles and all vegetable dishes.
8.	Fenugreek seeds (Methi)	Important component of masala powder and idli batter. Although bitter it enhances the flavour of pickles and gravies. **Medicinal use :** Reduces blood sugar levels, used to treat dysentery.

9.	Garlic	Used in chutneys, pickles, meat preparations, tomato ketchup, pulav, rasam etc. **Medicinal use :** Lowers blood cholesterol levels, used to treat digestive disorders, lowers blood pressure, inhibits the growth of fungi belonging to Aspergillus and Candida, has antibacterial properties and is a good antibiotic. Used to treat skin disease and ear ache. It is also anticarcinogenic.
10.	Ginger	Used as a component of pickles, curry paste/powder, chopped ingredient in spicing dishes like uppuma and in making ginger bread, ginger biscuit, ginger candy, ginger squash. **Medicinal use :** Reduces inflammation and pain in joints, used to treat migraine headaches and helps to relieve nausea.
11.	Nutmeg	Used for flavouring puddings and fruit pie. **Medicinal Use :** Used for its anti-microbial properties.
12.	Mace	Flavouring puddings and fruit pie, fish sauces, meat preparation, pickles. It is ground and used in cakes, cookies, chocolate dishes. **Medicinal use :** Used for its anti-microbial property.
13.	Onion	Raw rings used in salads and raita. Essential ingredient in curries and fried foods. Used in preparation of chutneys and pickles. Onion powder is a flavouring agent.

		Medical use : Used to lower blood glucose levels. It has antibacterial properties. Onion can lower blood cholesterol levels.
14.	Poppy seeds	Used for topping bread, cake, rolls or buns. Oil extract is used for salads. Used for thickening gravies and non-vegetarian dishes.
15.	Pepper	Seasoning foods like vadai, bonda, and pongal, used as a component of masala powder, used in pickling meat and in preparation of stews. Enhances flavour of salads, sandwich, papads, soups and omlettes. **Medicinal use :** Used in hot-milk for throat infection. Used in relieving body ailments.
16.	Saffron (kesar)	Essential garnish of mughalai dishes, mainly pulav and biriyani. Used as colouring agent (yellow), used in soups, sauces and sweets like rasamalai and srikand to give yellow colour. **Medicinal Use :** Used as a sedative and in eye infections.
17.	Tamarind	Used for flavouring sambhar and rasam. Used as souring agent in chutney pickle and tamarind rice and as a thickening agent in gravies.
18.	Turmeric	Colouring agent (yellow) and flavouring agent in all gravies, essential component of curry powders. Fresh foods are applied with turmeric paste after cleaning as it is a natural disinfectant. **Medicinal use :** It is a natural disinfectant. It is an antioxidant and

		reduces the progress of cancer. It is used for relieving stomach irritation, sore throat, cough, cold and flatulence, helps to reduce blood cholesterol levels.
19.	Mustard seeds	Seasoning curries and pickles, chutneys. **Medicinal use :** Used as body massage oil.
20.	Cumin (Jeera)	Flavouring curries, rasam, pickles, bread, sauces and cakes. **Medicinal use :** Stimulant and diuretic. Increases the levels of anticancer enzymes in the body.
21.	Cinnamon	Used in curry powders, seasoning meat preparations and is an ingredient in confectionery.
22.	Clove	Used as a table spice, used in preparation of curry powder, flavouring agent in pulav and biriyani. **Medicinal use:** Used in tooth pain. aids digestion, relieves muscular cramps and headache.
23.	Curry leaf	Seasoning in almost all south Indian dishes like rasam, sambhar, gravies and snacks like boondhi mixture, used in preparation of chutneys and powders.
24.	Coriander leaf	Used raw in salads and chutneys. Used as a flavouring agent and garnishing agent.

10.2 USES IN COOKERY

The role of spices and condiments in cooking are as follows.

Table 10 B

The role of spices and condiments in cooking

1.	Flavouring Agent	Eg. Cardamom adds flavour to payasam.
2.	Colouring Agent	Eg. Turmeric gives colour to lime rice.
3.	Preservative	Eg. Garlic, turmeric, fenugreek powder retard the growth and multiplication of bacteria in pickles.
4.	Souring Agent	Eg. Tamarind lends a sour taste to gravies, chutneys and pickles
5.	Thickening Agent	Eg. Poppy seeds, ginger garlic paste are used to thicken gravies.
6.	Medicinal Agents	Eg. Coriander seed, cumin seeds aid digestion while garlic, onion are used to reduce blood sugar and cholesterol leaves.
7.	Stimulants	Spices tend to increase appetite and therefore food intake.
8.	Imparts variety in foods	Different spices lend different flavours, colours and taste to food.
9.	Gives pungency	Chillies added to chutneys and ginger added to lime juice and tea give a characteristic burning sensory stimulation.

QUESTIONS

Part-B

Write short answers

1). What are the different spices used in our food?

2). What is the role of spices in food preparation?

Part- C

Write detailed answers

1). Discuss the medicinal value of spices and condiments in detail.

2). Explain the role of spices and condiments in food preparation.

11. SUGAR, JAGGERY AND HONEY

11.1 NUTRITIVE VALUE

Sugar, honey and jaggery are sweetening agents. They are added to beverages and foods to increase palatability. Sugar is made up of glucose and fructose.

It is a source of energy providing 4 kilocalories per gram. Jaggery is made from sugar cane juice after processing it. Jaggery is a fair source of iron. Palmyra palm, date palm or coconut palm is used for it.

Honey is the golden coloured syrup made by bees from the nectar of flowers. It is a mixture of glucose and fructose.

The nutritive value of sugar, honey and jaggery are given below:

TABLE – 11.A
Nutritive value per 100 g

Item	Energy (k cal)	Carbohydrate (g)	Calcium (mg)	Iron (mg)
Sugar	398	99.4	12	0.15
Jaggery	383	95.0	80	2.65
Honey	313	79.5	5	0.69

Source : Gopalan. C.,Rama Sastri B.V., Balasubramanian S.C., (1991) - Nutritive value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad.

11.2 STAGES OF SUGAR COOKERY

When sugar is boiled at different temperatures various products can be obtained.

TABLE – 11.B
STAGES OF SUGAR COOKERY

Product	Temperature	Test	Description of Test
Syrup	110 – 112°C	Thread	When syrup is dropped from a spoon, syrup spins a 5 cm thread.
Barfi, fondant, fudge	112 – 115°C	Soft ball	Forms a soft ball when syrup is dropped in cold water.
Caramels	118 – 120°C	Firm ball	Forms a firm ball when syrup is dropped into cold water, does not flatten on removal from water.
Divinity, laddu, marsh-mellow	120 – 130°C	Hard ball	Forms a ball hard enough to hold its shape when syrup is dropped in cold water.
Butter-scotch toffees	132 – 143°C	Soft crack	Forms threads which are hard but not brittle when syrup is dropped in cold water.
Brittle	150 – 154°C	Hard crack	Forms threads which are brittle when syrup is dropped.

Barley sugar	160°C	clear liquid	Sugar melts
Caramel	170°C	brown liquid	Sugar melts and browns.

Source : Shakuntala Manay N, Shadaksharaswamy. M (1987) - Foods, Facts and Principle, New Age International (P) Limited, New Delhi.

Two types of confectionery can be prepared when sugar is boiled viz., crystalline candies and amorphous candies.

Crystalline candies can be made by boiling sugar and water sufficiently to concentrate sugar to the point where a firm crystalline structure will form on cooling.

During preparation, butter and flavouring agents are added to enhance the quality of the product. They can be chewed and may easily be cut with a knife. They have a smooth velvetty texture. Eg. fondants and fudges.

Amorphous candies are boiled until they reach a high temperature. Concentration of sugar is far greater in amorphous candies (>90%) than in crystalline candies.

This high concentration of sugar prevents organisation of sugar crystals, hence the term amorphous candies. These candies easily crack.

Preparation of crystalline confectionary

Fondant:

Two hundred grams of sugar is dissolved in 120 ml of water and boiled till 113° C – 114° C. Cream of tartar and glucose are added and the mixture is concentrated by boiling until it reaches appropriate doneness.

The doneness of the candy is determined by measuring the temperature (113° C – 114° C) of the boiling solution. Another method of measuring doneness in the making of candies is by dropping a small portion of boiling syrup into very cold water allowing the syrup to cool and evaluating its consistency. In the case of fondant it is a soft ball shape.

The boiling solution is then poured on a smooth flat surface and allowed to cool at 40° C. Then it is beaten until it becomes a creamy mixture and ripened for 24 hours to promote smoothness.

Fudge:

In the preparation of fudge, butter and milk are added to prevent crystallisation. Fat and sugar are added to the solution after it reaches the boiling point (117° C). Apart from these changes, the principles of making fudge do not differ from those of making fondant.

Preparation of Non-Crystalline Confectionary

Crystallisation of sugar is prevented by cooking the solution to a high temperature so that the product hardens before crystals are formed. During cooking a brown colour develops due to the caramelisation of sugar.

Caramels are made by adding corn syrup, fats and concentrated milk products to the sugar syrup.

Brittles are made by melting and caramelisation of sugar. Toffee is made from sugar syrup with the addition of cream of tartar, vinegar or lemon juice. Gelatin is used in the preparation of spongy candies like marsh mellows.

11.3 ARTIFICIAL SWEETENERS

Artificial sweeteners are those substances used as substitutes for sugar.

Characteristics of an ideal sweetener :

- sweet or sweeter than sucrose.
- pleasant taste with no after taste.
- colourless
- odourless
- readily soluble
- stable
- economical

- non toxic
- does not promote dental caries.

Low calorie sweeteners :

Polyols :

Polyols occur in nature and are also synthesised from easily accessible carbohydrates such as starch, sucrose, glucose, invert sugar, xylose and lactose.

Sugar alcohols (xylitol, sorbitol, mannitol, lactitol and isomalt) are polyols. They are white crystalline, water soluble powders. Sorbitol is used in chocolates and diabetic foods. Mannitol is used in sugar free chewing gum and xylitol is used in pastries, jam, ice cream. The average calorific value is 2.4 k cal / g.

Non-caloric Sweeteners :

Cyclamate :

It is 30 times sweeter than sucrose. It was banned as studies revealed its role in the development of tumors.

Acelsulfame – K :

It can be used in cooked or baked products. It is a synthetic derivative of acetoacetic acid.

Alitame:

It is a dipeptide based amide. It is 2000 times sweeter than sucrose.

Aspartame :

It is made by combining two amino acids – aspartic acid and phenyl alanine. Methyl alcohol is then added to form a methyl ester. It is a white, crystalline powder that has a sugar like taste. It is used in soft drinks, instant tea and coffee.

Saccharin:

It is sodium orthobenzene sulphonamide or its calcium salt. It is 300 times sweeter than sucrose. According to the WHO recommendation only 0 – 2.5 mg / kg body weight is permitted daily.

Natural Non-Caloric Sweeteners :

Neohespiridine dihydrochalcone – It is isolated from citrus peel.

Glycyrrhizin – It is obtained from roots of leguminous plant Glycyrrhiza glabra.

Thaumatin – It is obtained from a West African fruit plant.

11.4 ROLE OF SUGAR IN COOKERY

1. It is used as a sweetening agent.
2. Used in the preparation of sugar syrup for sweets like gulab jamuns, fruit squashes.
3. It is a preservative in jams and jellies. High concentration of sugar prevents the growth of micro-organisms.
4. Sugar contributes to the flavour and colour of the product when it is caramelised.
5. It helps to improve texture of cake and confectionary.
6. It can be used to prepare sweets and candies.

QUESTIONS

Part-A

Fill in the blanks:

1). Sugar provides _____ k cal / g.

2). The iron content of jaggery is _____.

3). _____ confectionary cracks into pieces.

4). Fudge is a _____ confectionary.

5). Caramel is obtained when sugar is boiled to _____° C.

6). A hard ball is obtained at _____ temperature.

7). The calorific value of polyol is _____.

8). _____ is a synthetic derivative of acetoacetic acid and is used as a sweetener.

Part-B

Write short answers

1). Compare the nutritive value of sugar, honey and jaggery.

2). What is the difference between crystalline and non-crystalline confectionary?

3). How are fondants prepared?

4) Give the characteristics of artificial sweeteners

Part- C

Write detailed answers

1). Explain the various stages of sugar cookery. Highlight the importance of sugar in cookery.

2). Write a brief note on the different types of artificial sweeteners. What are the characteristics of an ideal sweetener?

12. BEVERAGES AND APPETIZERS

Beverages are drinks used for the purpose of relieving thirst and including fluid in the days diet. They contain nutrients and are also stimulants.

Appetizers are those liquids that improve the appetite of an individual. Eg. Soups.

Intake of appetizers before a meal tends to increase the quantity of food consumed and also stimulates a desire for food consumption.

12.1 USE IN A DAYS MENU

1. Refreshment :

Beverages such as plain or carbonated water, lime juice, ginger ale and other bottled beverages, fruit juices and iced tea or coffee are refreshing drinks and are used to relieve thirst.

2. Nourishment :

Pasteurized milk, butter milk, chocolate and cocoa drinks, eggnog made with rum, fruit juices, glucose water, lemonade provide nutrients and help in nourishing the body.

3. Stimulant :

Tea, coffee, cocoa and chocolate beverages help in stimulating the system.

4. Soothing Agent:

Warm milk and hot tea have a soothing effect and are used for this purpose.

5. Appetizers :

Soups, fruit juice and alcoholic drinks in limited quantities increase an individuals appetite and thereby food consumption.

12.2 NON ALCOHOLIC BEVERAGES :

Tea :

Tea is obtained from the leaves and flowers of tea bush. The kind of tea obtained is determined by the manufacturing process and treatment. Tea is a stimulating and refreshing drink.

The principle flavour components of tea are caffeine, tannin yielding compounds and small amounts of essential oils. Caffeine provides the stimulating effect, tannin the colour, body and taste to the extract and the essential oils contribute the characteristic aroma.

Tea can be prepared by introducing tea leaves into boiling water in a kettle or by pouring boiling water over tea leaves in a preheated tea pot and letting it steep.

The time of steeping depends on the strength of the beverage desired and quantity of tea leaves used. To prepare good tea one teaspoonful of tea leaves for 1 cup is ideal.

The tea should be brewed only for five minutes and strained. If it is kept for more than five minutes it will give a bitter taste. Milk and sugar should be added to individual taste.

Coffee:

Coffee is prepared from the beans of the coffee plant. Caffeine and flavouring substances such as tannins determine the quality of the end products.

Coffee can be prepared by filtration and percolation.

Filtration:

This is a very common method used in the preparation of coffee. A coffee filter is used for this purpose. Coffee powder is placed in the top part of the filter and covered with a disc, which is perforated.

Boiling water is poured over the coffee powder and it drift through it and extracts the flavour and aroma.

Percolation :

In this method the heated water is forced upward through a tube into the coffee compartment. When it filters through, it extracts the coffee flavour.

The water filters through the coffee several times before the desirable strength is obtained.

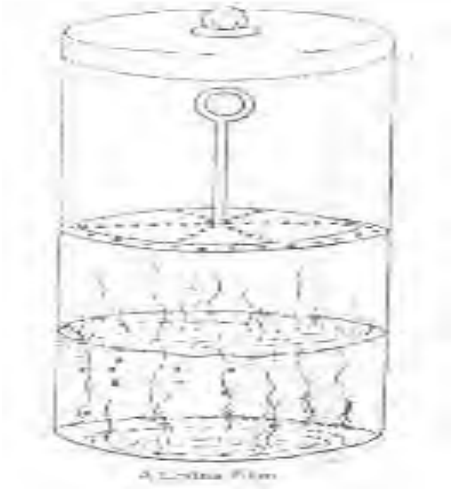


Fig12.1 Coffee filter

Source: Sumati Mudambi, R Shalini Rao M.,1989,Food Science, New Age International (p) Publishers Limited

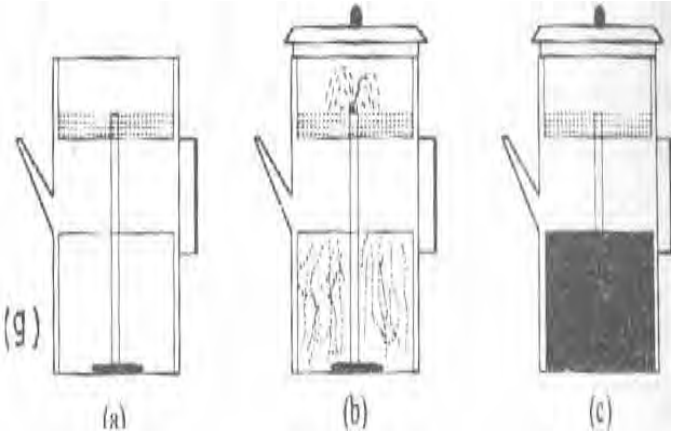


Fig 12.2 Percolation

Source: Sumati Mudambi, R Shalini Rao M.,1989,Food Science, New Age International (p) Publishers Limited

Instant coffee :

Instant coffee is prepared by pouring boiling water over instant coffee powder in a dry cup.

Cocoa And Chocolate:

Cocoa and chocolate are made from grinding the seeds of cocoa bean pods. Chocolate and cocoa unlike coffee and tea have a higher nutritive value.

The percentage nutritive value of chocolate and cocoa are given in the following table.

TABLE – 12.A

Percentage nutrient composition of cocoa and chocolate

Constituents	Cocoa	Chocolate
Water	4.6	5.9
Protein	21.9	12.9
Fat	28.6	48.7
Carbohydrates	32.7	30.0

Cocoa should always be mixed with a small amount of cold liquid before being combined with other ingredients. This prevents the formation of lumps.

It is then heated to boiling and held at that temperature to extract the flavour and reduce the amount of sediment that settles at the bottom.

Fruit Beverages :

Fruit beverages are obtained by extracting the juice from fruits such as orange, grape, pineapple, lemon, tomato etc.

These juices are an excellent source of vitamins, minerals and energy depending on the fruit used. Fruit juices are not only refreshing, they are nutritious, and increase fluid intake.

Fruit squashes are prepared by combining sugar syrup and fruit juice. They have a long shelf life and can be readily mixed with water to obtain an instant refreshing drink.

Fruit pulp can be combined with milk and sugar to form milk shakes e.g. apple, mango, sapota etc.

Milk Beverages :

Milk beverages are prepared by the addition of different flavours viz. strawberry, pista, cardamom and chocolate to milk.

They enhance the flavour of milk and thereby increase its consumption particularly by young children. Milk beverages are a good source of protein, calcium and vitamin A and B.

Milk shakes are prepared by mixing fruit pulp with milk and sugar. Milk can be mixed with egg to prepare egg nog which is a nourishing drink with a creamy consistency.

12.3 CARBONATED NON-ALCOHOLIC BEVERAGES

Carbonated non-alcoholic beverages are those beverages that are generally sweetened, flavoured, acidified and coloured.

The chief ingredient is water and this may be to the extent of 92 percent. The beverage contains 8 to 14 percent of sugar which contributes to the sweetness, calorie and body of the drink.

Artificial sweeteners such as saccharin is also used. Carbon dioxide is added to produce the tingling effect, sparkle and effervescence of carbonated beverages.

Nutritionally, it is an empty food since it provides only calories and no other nutrients. A bottle of an aerated beverage (180 ml) gives 70 kilo calories of energy.

Phosphoric acid, citric acid, fumaric acid and tartaric acid which are added to enhance the flavour, makes the drink acidic. It is therefore not recommended for patients suffering from acidity and ulcers. Saccharin which is a suspected carcinogen is also present in aerated drinks. Children should not be encouraged to consume carbonated beverages since they have no food value and depress the appetite.

12.4 MALTED BEVERAGES

Malted beverages are also known as Amylase Rich Foods (ARF). This is prepared by steeping whole grain like ragi or wheat in 2 – 3 times its volume of water.

The excess water is drained and the moist seed is germinated for 24 – 48 hours till sprouts appear. The grains are sun-dried and roasted to remove moisture. Sprouts are removed and the grains are milled and powdered.

The malt is cooked with water or milk to prepare a nutritious beverage.

ARF is rich in enzyme amylase. The germination process activates the enzymes of the resting grain and facilitates the conversion of cereal starch to fermentable sugars. Hydrolysis of cereal proteins also takes place.

12.5 TRADITIONAL BEVERAGES

Nera :

Nera is a sweet drink from the fresh sap of palm.

Tender Coconut Water :

This is a refreshing drink obtained from coconut. Potassium, ascorbic acid and many vitamins of the B group are present in coconut water. Apart from this, the water also contains traces of calcium, phosphorus and iron.

Sugarcane juice :

Sugarcane juice extracted from sugarcane contains 12 – 15 percent sugar. The cane juice is acidic and in addition to sugar contain minerals and vitamins such as the B – group.

Panakam :

Panakam is a traditional drink prepared using jaggery, ginger and cardamom.

12.6 ALCOHOLIC BEVERAGES

Beer, ale, toddy, wine, whisky, gin and brandy are some of the commonly used alcoholic beverages. Alcoholic beverages are obtained by the enzymatic fermentation of yeast which converts glucose to alcohol.

Beer :

Beer is made by fermenting barley malt extract with yeast while ale is the same product with more stimulation.

Wine :

Wine is prepared by the fermentation of grapes with yeast.

Toddy :

This is prepared by fermenting the sap of palm, coconut, palymra or date palm.

Whisky :

It is an alcoholic distillate from a fermented mash of grains.

Gin :

It is an artificial drink from diluted pure ethyl alcohol.

Brandy :

This is made by fermenting fruit juices like grapes and apples.

Alcohol is a narcotic, a drug and sedative. It is very rapidly absorbed in the body. Excessive consumption of alcohol causes damage to the liver, stomach and blood vessels.

It also leads to diabetes mellitus, cardiovascular diseases, cirrhosis of the liver and gastric ulcers.

12.7 SOUPS

Soups are prepared with vegetables, pulses, poultry and meat. The food which is to be used for making soup is cooked thoroughly in plenty of water. Clear soups are prepared using only the water in which the food is cooked while cream soups are prepared by adding milk and white sauce to the water.

Soups provide us with a variety of nutrients depending on the ingredients used. Soups also enhance appetite and add colour to the meal. It is usually served at the beginning of a meal.

QUESTIONS

Part-A

Fill in the blanks

1). To prepare good tea, _____ teaspoonful of tea leaves for 1 cup is ideal.

2). Coffee is classified as a _____ beverage.

3). The protein content of cocoa is _____.

4). Fruit squashes are prepared by combining _____ and _____.

5). The mineral present in significant amounts in milk beverages is _____.

6). Carbonated non-alcoholic beverage contain _____ percent of sugar.

7).The expansion of ARF is _____.

8). Nera is prepared from _____.

9). Tender coconut water is a significant source of the mineral, _____.

10). The pH of sugarcane juice is _____.

11). Jaggery, ginger and cardamom are used in preparing a traditional beverage called _____.

12). In the preparation of alcoholic beverages _____ is converted to _____ by the fermentation of _____.

13). Beer is made by fermenting _____.

14). The alcoholic distillate from a fermented mash of grain is _____.

Part- B

Write Short answers

1). Highlight the use of beverages in the day' s menu.

2). Write a short note on the preparation of tea.

3). Describe the filtration and percolation method of preparing coffee.

4). Compare the nutritive value of cocoa and chocolate.

5). Discuss the nutritional significance of fruit beverages and soups.

6). How are malted beverages prepared? Highlights its nutritional significance in the diet.

7).Write a short note on traditional beverages.

Part- C

Write detailed answers:

1). Differentiate alcoholic and non-alcoholic beverages. Discuss different types of alcoholic beverages and highlight the dangers involved in consuming excessive alcoholic beverages?

2). What are the different types of non-alcoholic beverages? Write a short note on any three of them. Highlight the use of beverages in the day' s menu.

3). What are the ingredients used in the preparation of carbonated beverages? Would you recommend a fruit beverage on a carbonated beverage for a teenager? Justify your choice.

13. FOOD PRESERVATION

Food is the basic necessity of man and is invaluable for healthy existence. However, most foods fit for consumption undergo deterioration and spoilage. In order to combat this problem foods have to be preserved.

Food preservation can be defined as the science that deals with the process of prevention of decay or spoilage of food thus allowing it to be stored in a fit condition for future use. Preservation of food increases the shelf life of foods and thus ultimately ensures its supply during times of scarcity and natural drought.

13.1 FOOD SPOILAGE

Food spoilage is a state in which food is deprived of its good or effective qualities. Deterioration or spoilage starts from the time food is harvested slaughtered or manufactured and results in undesirable changes in the physical and chemical characteristics of food.

Causes of food spoilage :

- Growth and activity of microorganisms such as bacteria, yeast and moulds.
- Activities of food enzymes and other chemical reactions within the food.
- Inappropriate temperatures for a given food.
- Gain or loss of moisture.
- Reaction with oxygen and light.
- Physical stress or abuse.
- Insects and rodents.
- Non-enzymatic reactions in food such as oxidation and mechanical damage.

13.2 PRINCIPLES OF FOOD PRESERVATION

1. Prevention or delay of microbial decomposition.
    a) by keeping out micro organisms (asepsis)
    b) by removal of micro organisms (eg. filtration)
    c) by hindering the growth and activity of micro organisms. (eg.) refrigeration, dehydration, addition of chemical preservatives.
    d) by killing micro organisms. (eg.) boiling, irradiation.
2. Prevention or delay of self-decomposition of food.
    a) by destruction or inactivation of enzymes. eg. by blanching. The steaming or boiling of fruits or vegetables in water for few minutes to inactivate natural enzymes and facilitates removal of skin is known as blanching.
    b) by prevention or delay of purely chemical reactions. eg. prevention of oxidation by the use of anti-oxidants.
3. Prevention of damage caused by insects, animals and mechanical causes.

13.3 METHODS OF FOOD PRESERVATION

A perusal of the history of food preservation reveals that food preservation had its beginning from time immemorial and could be traced to nearly a thousand years ago.

Salting of meat, fish, and vegetables was the oldest method of preservation and could be traced back to the ancient Egypt and Greek civilisations.

Pickling in salt and vinegar, sun-drying and preservation of fruits and vegetables in sugar and honey were among the other methods used.

Storage of food in frozen conditions was also practiced for centuries in places where freezing temperatures were recorded.

The discovery of canning as a standard technique of preserving foods in sealed containers subject to high temperature was established in 1810 by Nicholas Appert. Around 1860, Louis Pasteur discovered that microbes were the main cause of spoilage and introduced a heat treatment known as pasteurisation to the world.

All methods used for food preservation are based on preventing or retarding the cause of spoilage.

When growth of micro organism is only retarded, preservation is temporary. When spoilage organisms are completely destroyed a more permanent preservation is achieved.

13.3.1 Use Of Low And High Temperatures :

Use of Low Temperatures

Microbial growth and enzyme reaction are retarded in foods stored at low temperatures.

The lower the temperature, the greater the retardation. The low temperatures employed can be:

1. Cellar storage temperature (about 15º C)
2. Refrigerator or chilling temperature (0º C to 5º C).
3. Freezing temperature (-18º C to -40º C).

Cellar storage temperatures (about 15º C)**:**

Temperatures in cellars (under ground rooms) where surplus food is stored in many villages are usually not much below that of the outside air and is seldom lower than 15º C.

The temperature is not low enough to prevent the action of many spoilage organisms or of the plant enzymes. Decomposition is however, slowed down considerably.

Root crops, potatoes, onions, apples and similar foods can be stored for limited periods during the winter months.

Refrigerator or Chilling Temperature (0º C to 5º C)

Chilling (refrigerator), temperatures are obtained and maintained by means of ice or mechanical refrigeration.

Fruits and vegetables, meats, poultry, fresh milk and milk products, fish and eggs can be preserved from two days to a week when held at this temperature.

In addition to the foods mentioned above, foods prepared for serving or left-overs may also be stored in the household refrigerator. The best storage temperature for many foods, eggs, for example, is slightly above 0^{o} C.

The optimum temperature of storage varies with the product and is fairly specific for any given food.

Besides temperature, the relative humidity and the composition of the atmosphere can affect the preservation of the food.

Commercial cold storages with proper ventilation and automatic control of temperatures are now used throughout the country (mostly in cities) for the storage of semi perishable products such as potatoes and apples. This has made such foods available throughout the year and has also stabilized their prices in these cities.

Low temperatures chiefly inhibit the growth of microorganisms although freezing may result in the destruction of some microorganisms.

Freezing temperature:

Freezing may preserve foods for long periods of time provided the quality of the food is good to begin with and the temperature of storage is far below the actual freezing temperature of food.

Some microorganisms are destroyed during freezing preservation. The chief preservative effect of freezing temperatures lies in the inability of microorganisms to grow at freezing temperature.

In vegetables, enzyme action may still produce undesirable effects on flavour and texture during freezing. The enzymes therefore must be destroyed by heating before the vegetables are frozen.

Slow freezing process

It is also known as sharp freezing. In this method, the foods are placed in refrigerated cabinets at temperatures ranging from -4º C to -29º C. This method is adopted in home-freezers. Freezing may require from 3 to 72 hours under such conditions.

Quick freezing process

The lower temperatures used -32º C to -40º C freeze foods so rapidly that fine crystals are formed and the time of freezing is greatly reduced over that required in sharp freezing.

The fine crystals formed by quick freezing have a lesser effect on breaking up plant and animal cells than do methods of slow freezing that produce coarser ice crystals.

In quick freezing, large quantity of food can be frozen in a short period of time.

Dehydro freezing

Dehydro freezing of fruits and vegetables consists of drying the food to about 50 percent of its original weight and volume and then freezing the food to preserve it.

The quality of dehydro frozen fruits and vegetables is equal to that of fruits and vegetables frozen without preliminary drying.

The cost in packing, freezing, storing and shipping of such foods is less because of the reduction in weight and volume of foods during dehydro-freezing .

The following figure depicts the relationship between bacterial growth and temperature. The rapid growth of bacteria occurs in the temperature zone of 60° F –120° F

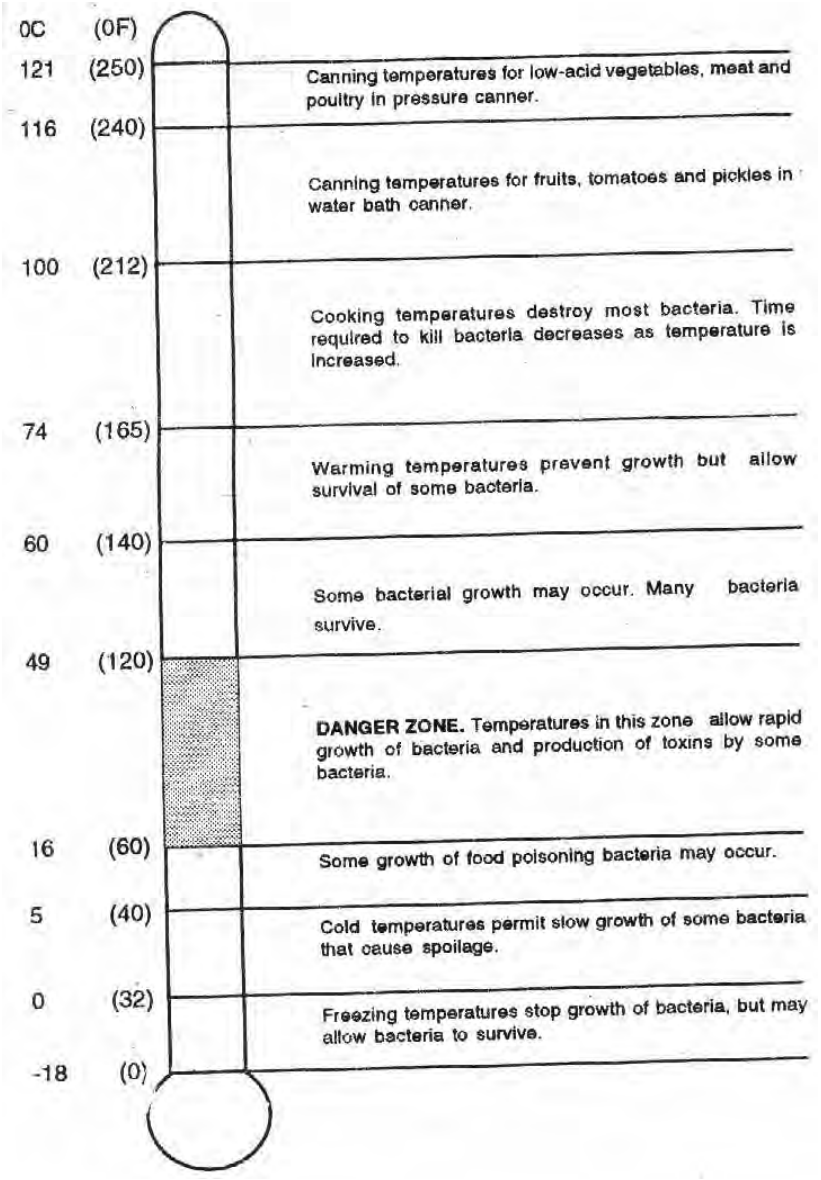


Fig.13.1 Temperature in relation to bacterial growth

Source : Srilakshmi. B (2003) Food Science, New Age International Publishers, Chennai.

Use of heat or high temperatures:

The destruction of microorganisms by heat is due to the coagulation of the protoplasm. The temperature and time used in heat processing a food depend upon the nature of the food and what other methods are combined with heat.

The various degrees of heating used in preservation of food can be classified into three (a) Pasteurisation, (b) Heating upto 100º C or 212º F and (c) Heating above 100º C.

(a) Pasteurization

The time and temperature used in the pasteurization process depend upon the product treated and the method used. In pasteurization, most of the spoilage organisms are killed but a few survive and hence must be inhibited by low temperatures or some other method, if spoilage is to be prevented.

There are two methods of pasteurization – flash method and holder method. In flash method, otherwise called high-temperature short time method, a high temperature for a short time is used, while in the holder method or low-temperature long-time method, a lower temperature for a longer time is used. There are slight variations in the time and temperature used for pasteurizing different foods, like milk, cream, ice cream mix and wines.

(b) Heating up to a temperature of about 100º C

Most methods of cooking come under this. This temperature can be obtained by boiling any liquid food, by immersing a container in boiling water or by exposure to steam. Before the use of pressure cookers and autoclaves, canning was done at 100º C and this killed all bacteria except spores.

(c) Heating above 100º C(212º F)

Temperatures above 100º C are obtained by means of steam under pressure as in a pressure cooker or autoclave. Sterlisation of foods can be brought about at 121º C for 15 minutes under moist conditions.

CANNING PROCEDURE

The details of canning procedures vary with the nature of the food to be canned, but there are certain important operations common to canning of all foods.

(1) Cleaning (2) Blanching (3) Exhausting, (4) Sealing the container (5) Sterilizing the sealed container and (6) Cooling the container

1. Cleaning :

The first step in canning, whether done in the home or on a large scale in factories, is the thorough cleaning of the raw food to be preserved. By this means most of spoilage organisms are removed.

On a large scale, cleaning is done with the help of various kinds of washers. The raw materials may be subjected to high pressure sprays or strong flowing streams of water, while passing along a moving belt.

2. Blanching:

Blanching consists of the immersion of raw food materials, especially vegetables and fruits, into hot water or exposure to live steam.

Blanching serves as an additional hot water wash. It softens fibrous plant tissues, inhibits the action of enzymes and fixes the natural colour of certain products making them more attractive in appearance.

3. Exhausting:

Gases are expelled by passing the open can containing the food through an exhaust box in which hot water or steam is used to expand the food and expel air and other gases from the contents and the head space area of the can. After the gases are expelled, the can is immediately sealed, heat processed and cooled.

In the case of certain products, exhausting is done by mechanical means, rather than by the use of heat. There are

special machines which withdraw the air from the cans and they seal them at the same time – "vacuum packing".

4. Sealing the container:

Each container must be sealed properly before it is subjected to the heat process, since re-contamination of the contents must be prevented.

5. Sterilizing the sealed container with its contents by heat processing

This is meant to bring about complete sterilisation to prevent spoilage of the food by microorganisms. This is usually done by the application of steam under pressure.

The temperature and time used for heat processing depend on the kind of food, on the pH of the medium and other factors. It should however be remembered that an excessive period of heating at higher temperatures than necessary will spoil the product.

A longer exposure to a relatively low temperature should be preferred to a short exposure at a higher temperature.

6. Cooling the container

The containers should be cooled rapidly to check the action of heat and prevent unnecessary softening of the food or change in colour of the contents. Cooling can be done by means of air or water.

13.3.2 Drying :

Microorganisms need moisture to grow. When exposed to sunlight or subjected to dehydration, the moisture in the food is removed and the concentration of water is brought below a certain level. This prevents the growth of microorganisms and thereby spoilage of food.

Food preservation by drying is one of the oldest methods practised from ancient times. This method consists of exposing food to sunlight and air until the product is dry.

Treatment of foods before drying

- Selection and sorting for size, maturity and wholesomeness.

- Washing, especially of fruits and vegetables.
- Peeling of fruits and vegetables by hand, machine or abrasion.
- Subdivision into halves, slices, shreds or cubes.
- Blanching or scalding of vegetables and some fruits like apricots and peaches.
- Sulphuring of light coloured fruits and vegetables. Fruits are sulphured by exposure to sulphur di oxide gas produced by the burning of sulphur to a level of 1,000 to 3,000 ppm.

Methods Of Drying

Sun drying

It is limited to regions with hot climates and a dry atmosphere and to certain fruits such as raisins, prunes, figs, apricots, pears and peaches. It is a slow process.

Many Indian foods are preserved by sun drying. Papads and vathals are made using this principle. Vegetables like cluster beans and curd chilli and fruits like jack fruit are preserved by this method. Fish and meat are also sun dried.

Drying by mechanical driers

Most methods of artificial drying involve the passage of heated air with controlled relative humidity over the food to be dried or the passage of the food through such air.

Fruits, vegetables, nuts, fish and meat can be successfully preserved by this method. In the dehydration process, artificial drying methods (eg. spray drier) are used for drying foods. Although it is expensive when compared to natural sun-drying procedures, it is very advantageous because the temperature and relative humidity can be manipulated.

Spray drying

Milk and egg are dried to a powder in spray driers in which the liquid is atomized and sprayed into a hot air stream for almost instant drying.

Foam mat drying

Foam mat drying may be used commercially with orange and tomato juice. In this process a small amount of edible foam stabilizer such as monoglycerides or a modified soyabean protein with methyl cellulose is added to the liquid and a stiff foam is produced by whipping. The foam is spread in a thin layer and dried in a stream of hot air. The product separates easily into small particles on cooling.

Drying by osmosis

Drying also results when fish is heavily salted. In this case, the moisture is drawn out from all cell tissues. The water is then bound with the solute, making it unavailable to the microorganisms.

In osmotic dehydration of fruits, the method involves the partial dehydration of fruits by osmosis in a concentrated sugar solution or syrup.

Freeze drying

Removal of water from a product while it is frozen by sublimations is called freeze drying.

Factors to be considered in drying foods

- The temperature employed, which will vary with the food and the method of drying.
- The relative humidity of the air. It usually is higher at the start of drying than later.
- The velocity of the air.
- The duration of drying.

13.3.3 Use Of High Concentration Of Sugar And Salt :

Sugar and salt aid in the preservation of products in which it is used due to their ability to bind water and make it unavailable for microbial growth. Salt is an effective preservative because it also ionises to yield chlorine ion, which is harmful to organisms and reduces the solubility of oxygen in moisture, which are essential for the growth, and multiplication of microorganisms.

Jams, jellies and fruit juices are an important class of fruit products preserved using high concentration of sugar. Pickles are preserved using high concentration of salt.

Jam :

Jams are prepared by boiling fruit pulp with sufficient amount of sugar to a reasonably thick consistency, firm enough to hold the fruit tissue in position. In preparing jam, the fruit is crushed or finely cut and measured quantity of sugar and preservatives are added so that when cooked, the mass is fairly uniform throughout.

Jams can be prepared from all varieties of pulpy fruits such as grapes, mango, sapota, banana, guava etc.

Jelly :

Jellies are prepared by boiling fruits in water. The extract obtained is strained and measured quantity of sugar is added to it. The mixture is then boiled to a stage at which it will set to a clear gel. A perfect jelly should be transparent, well set, but not too stiff and should have the original flavour of the fruit. It should retain its shape when removed from the mould. Usually fruits such as guava, pineapple, apple, grape and a mixture of fruits rich in pectin can be used for the preparation of jellies.

Fruit Juices :

Fruit beverages are prepared from different fruits such as apple, mango, grapes, lime, pineapple, sapota and in different forms such as pure juices, crushes, squashes and cordials.

The ratio of sugar and fruit juice in the preparation of various beverages are as follows :

Crushes	-	25% fruit juice and 55% sugar.
Squashes	-	25% fruit juice and 45% sugar.
Cordial	-	Clarified juice 1 litre and 250 gm sugar.

In the preparation of fruit juices, citric acid is usually added to clarify the sugar syrup. Preservatives such as sodium benzoate are added to tomato and grape juices while potassium meta bi-sulphite (KMS) is added to all other fruit beverages.

Pickling :

The preservation of fruits and vegetables in common salt, vinegar, oil and spices is referred to as pickling. Salt binds the moisture in the food and thereby prevents the growth of microorganisms.

The layer of oil that floats on the top of pickles prevents the entry and growth of microorganisms like moulds and yeast. Spices, like turmeric, pepper, chilli powder and asafoetida retard the growth of bacteria.

Vinegar lowers the pH of the product thereby providing an unfavourable acidic environment for microbial growth. Mango, lime, ginger, garlic, tomato, chilli, mixed vegetables such as beans, carrot, cauliflower and peas are used widely in the preparation of pickles.

13.3.4 Use Of Chemical Preservatives

Preservatives are defined as chemical agents which serve to retard, hinder or mask the undesirable changes in food. These changes may be caused by micro organisms, by enzymes of food or by purely chemical reactions.

Certain chemicals when added in small quantities can hinder undesirable chemical reaction in food by:

1. Interfering with the cell membrane of the microorganism, their enzyme activity or their genetic mechanism.
2. Acting as antioxidants.

Maximum amounts allowed to be added to each type of food is regulated by law because higher concentrations can be a health hazard. Benzoic acid in the form of its sodium salt is an effective inhibitor of moulds and is used extensively for the preservation of jams and jellies.

Some of the other chemical preservatives used are:

1. Potassium metabisulphite
2. Sorbic acid

3. Calcium propionate
4. Sodium benzoate

The development of off-flavours (rancidity) in edible oils is prevented by the use of Butylated Hydroxy Anisole(BHA), Butylated Hydroxy Toluene(BHT), lecithin which are some of the approved antioxidants.

13.3.5 Radiation

Radiant energy can be used to preserve food. Gamma rays and beta particles produced by special electronic machines are sources of energy used to preserve food.

These waves penetrate throughout the food. As the waves and particles pass through the food, they collide with molecules in the food and in microorganisms. These result in chemical alterations. The goal of irradiation is to kill the microorganism and inactivate the enzymes without altering the food.

Changes in the food are minimized if it is done in a vacuum, and if **ascorbic** acid is present. Berries and meat are preserved in this way.

Questions

Part- A

Fill in the blanks :

1. Keeping out of microorganism is known as _____.
2. Low temperatures _____the growth of microorganisms.
3. High temperatures _____ the growth of microorganisms.
4. Artificial drying is known as _____.
5. Jam is prepared using fruit _____ while jelly is prepared using fruit _____.

6. The preservation of fruits and vegetables using salt, vinegar, oil and spices is known as _____.
7. Fruit squashes contain _____% sugar and _____% fruit juice.
8. During the canning process, fruits and vegetables are blanched in order to _____ and _____.

Part - B

Write short answers

1. Define preservation. What are the principles of food preservation?
2. What are the causes of food spoilage?
3. How does salt and sugar lend themselves as preservatives?
4. Differentiate jams and jellies.
5. What are the functions of the ingredients used in pickling?
6. Write a note on chemical preservatives and its use?

Part- C

Write detailed answers

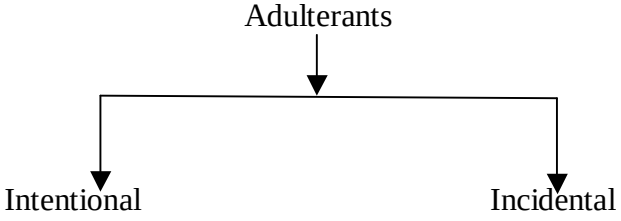
1. How do low temperature procedures prevent spoilage? Discuss the methods.
2. Give a brief account on any four techniques employed in food preservation.
3. Explain the use of high temperature in preservation?
4. Define Canning. Explain the steps in canning?
5. Give a detailed account on drying as a method of preservation. Write a note on the different types of drying?

14. FOOD ADULTERATION

14.1 DEFINITION

Adulteration is defined as the process by which the quality or the nature of a given substance is reduced through the addition of a foreign or an inferior substance and the removal of a vital element.

14.2 TYPES OF ADULTERANTS



Intentional :

Intentional adulterants are those substances that are added as a deliberate act on the part of the adulterer with the intention to increase the margin of profit. Eg. sand, marble chips, stones, mud, chalk powder, water, dyes, etc., These adulterants cause harmful effects on the body.

Incidental :

These adulterants are found in food substances due to ignorance, negligence or lack of proper facilities. It is not a willful act on the part of the adulterer. Eg. pesticides, droppings of rodents, larvae in food.

14.3 TESTS FOR DETECTING ADULTERANTS

Simple tests for the detection of adulterants present in foods are given in the following table :

TABLE 14.A

Tests for determining common adulterants present in food

Sl. No.	Substance	Adulterant	Test
1.	Asafoetida (Hing)	Resin or gum scented and coloured	a) Pure asafoetida dissolves in water to form a milk-white solution. b) Pure asafoetida burns with a bright flame on being ignited (burning)
2.	Sugar	Chalk Powder	Dissolve in a glass of water. Chalk will settle down in the bottom.
3.	Cardamom	Oil is removed and pods are coated with talcum powder.	On rubbing, talcum will stick to the fingers. On testing, if there is hardly any aromatic flavour, it indicates removal of essential oil.
4.	Turmeric (Haldi)	Metanil Yellow colouring	When concentrated hydrochloric acid is added to a solution of turmeric powder, it turns magenta if metanil yellow is present.
5.	Chilli powder	Sawdust and colour	Sprinkle on the surface of water, sawdust floats. Added colour will make the water coloured.

6.	Coffee	Chicory	Shake a small portion in cold water. Coffee will float while chicory will sink, making the water brown.
7.	Coriander powder	Horse dung powdered	Soak in water. Horse dung will float which can be easily detected.
8.	Cloves(Lavang)	Oil may be removed	If so, cloves may be shrunken in appearance.
9.	Cumin seeds (Jeera)	May contain grass seeds coloured with charcoal dust	If rubbed in hand, fingers will turn black.
10.	Ghee	Vanaspathi	Dissolve one teaspoon of sugar in 10 ccs of hydrochloric acid and 10 ccs of the melted ghee and shake thoroughly for one minute. Allow it to stand for 10 minutes. If vanaspathi has been added, the aqueous layer will be red in colour.
11.	Jaggery	Metanil yellow	Hydrochloric acid added to a solution of jaggery will turn its colour to magenta.

12.	Rawa	Iron filing to add weight	Pass magnet through the rawa. Iron filings will cling to it.
13.	Betelnut powder (Supari)	Sawdust and artificial colour	Sprinkle in water. Sawdust will float and the added colour will dissolve in water.
14.	Milk	a. Mashed potato, other starches b. Water	Add a drop of tincture of iodine. Iodine, which is brown turns blue if starch is present Put a drop of milk on a polished vertical surface and allow to flow. Pure milk flows slowly leaving a white trail. Adulterated milk will flow immediately without leaving a mark.
15.	Tea dust	Used tea leaves dried, powdered and artificially coloured.	Sprinkle the dust on a wet white filter paper. Spots of yellow, pink and red appearing on the paper indicates that tea is artificially coloured.
16.	Edible oil	Argemone	A reddish-brown precipitate is formed when oil and hydrochloric acid are gently mixed with ferric chloride solution, if argemone is present.
17.	Saffron	Maize	a) Genuine saffron is

		fibres dried, coloured and scented	tough. Spurious saffron is brittle and breaks easily. b) Dissolves easily in water, giving aroma of saffron.
18.	Sago	Sand and talcum	Gritty feel in mouth. Pure sago swells on burning and leaves hardly any ash.
19.	Black pepper	Dried seeds of papaya fruit	Papaya seeds are shrunken oval in shape and greenish brown in colour and has a repulsive flavour distinct from the bite of black pepper.
20.	Coconut oil	Any other oil	Place a small bottle of oil in refrigerator. Coconut oil solidifies leaving the adulterant as a separate layer.
21.	Bajra	Fungus (Ergot infested)	Immerse in salt water. Fungi will float to the top.
22.	Cinnamon (Dalchini)	Cassia bark	Added colour comes off in water.
23.	Common salt	White powdered stone, chalk	Stir a spoonful of simple salt in a glass of water. The presence of chalk will make the solution white
24.	Honey	Molasses (sugar and	A cotton wick dipped in pure honey when

		water)	lighted with a match stick burns, if adulterated it will not burn and will produce a cracking sound.
25.	Peanut oil	Cottonseed oil	Mix 2.5 ml of oil or fat with 2.5 ml Halphen' s reagent. Lightly screw cap and heat in boiling water for 30 minutes. The test is positive if a rose colour is obtained.

14.4 PACKAGING MATERIALS AND HAZARDS

Materials used for packing

The conventional methods of packing which are prevalent even now to a large extent are tin or aluminium containers, glass bottles and jars, paper and waxed paper wrappings, paper cartons, cardboard and certain plastic containers. Tin and aluminium containers have become costly and glass bottles though very good in many respects have problems associated with breakage and heavy transportation charges on account of weight. Continued use of paper in increased volume dwindles the natural resources.

Against the conventional materials there has emerged increased usage of newer materials derived synthetically. Some polymeric plastic materials are polystyrene, polyvinyls, polyvinydines and derivatives, vinyl acetate, poly ethylene, polypropylene and polyesters.

Folding cartons and paper board boxes are used extensively in the food industry. Tin plate containers–the cylindrical open-top variety are mostly used for processed foods. Aluminium is used principally as foil e.g., chocolates. It is also used as bottle caps and closures and easy open tops for cans.

Polystyrene is principally made into tubs for ice creams, packs for eggs, sausages and small packages for butter, jam and cheese. Bags made from the simplest of all plastic polymers, namely, polyethylene or ‘polythene’ as commonly known have relatively low preserving qualities. Material such as polyesters vinyl acetate derivatives and multilayer films made out of a combination of different materials have good preserving characteristics for food products.

Timber crates are used extensively for packing weights above 100 kg. Plastic crates are well established in the dairy industry and for the transportation of bottled beer, mineral water and soft drinks. High density polythene is used for milk crates.

Shrink wrap packaging is a system where heat shrinkable thermoplastic film is wrapped around an article or a group of articles. The film is made to shrink around it by the application of heat to achieve a skin light package. Canned food products, bottles and jars of all types can be shrink wrapped.

Now-a-days it is expected that packaging material be environment friendly or ecofriendly, that is, it should not pose many problems for mankind and hazards to the environment. For example, corrugated boxes are ecofriendly and are preferred for exporting. They can be effectively replaced for conventional wooden boxes which need to destroy the trees. Recyclability of packaging is desirable so as to preserve the resources of the packaging material for future generations.

Packaging Hazards:

Plastics such as cellulose acetate, polyamide polyethylene polypropylene and polyvinyl chloride are often used as packing materials because they are light in weight and are resistant to diffusion due to solvents and high temperatures.

However care should be taken that only food grade plastic packing materials should be used for packaging foods to prevent the following packaging hazards.

1. Production of noxious thermal breakdown products which are injurious to health.
2. Formation of toxic residues that result when subjected to heat treatment for sterilisation of the contents.
3. Unfavourable reactions between acid and oil content of the food and the packaging material.

14.5 FOOD LAWS AND STANDARDS

Prevention of Food Adulteration Act.

The prevention of Food Adulteration Act, (PFA) 1954 operated by the Directorate General of Health Services, Ministry of Health was designed for the following purposes :

1. It formulates and monitors the standard of quality and purity of foods with emphasis on prevention of adulteration of foods.
2. It is the basic structure intended to protect the common consumer against the supply of adulterated foods.
3. It makes provision for prevention of adulteration of food and lays down the rule that no person shall manufacture for sale, store, sell or distribute any adulterated or misbranded food or food which contravenes the provision of act or rules.
4. It has set the yardstick to ascertain adulteration. According to this act, a food is deemed to be adulterated – if:

Ø It is not of the nature, substance and quality, which the food ought to be.

Ø It contains any other substance which affects, or if the article is so processed so as to affect injuriously the nature, substance and quality of the food.

Ø It contains added inferior or cheaper substance that affects the nature and quality of the food.

Ø Any constituent of the food is removed so as to affect injuriously the nature, quality and substance of the food.

Ø It is prepared, packed and stored under unsanitary conditions.

- Ø It contains any filthy, disgusting, rotten, decomposed substance of a diseased animal or vegetable substance or is insect-infested or otherwise unfit for human consumption.
- Ø The article is obtained from a diseased animal.
- Ø The article contains a poisonous ingredient or any other ingredient injurious to health.
- Ø The container renders the food injurious to health.
- Ø It contains excessive or prohibited colours.
- Ø It contains excessive or prohibited preservatives.
- Ø It does not satisfy the standards prescribed by the authorities.

Under the provision of the PFA Act, the Government of India has promulgated PFA rules which specifies the following details:

1. Qualification, duties and functions of food analysts, food inspectors and central food laboratory.
2. Procedure for drawing test samples and sending them to the analyst and laboratory.
3. Specification for the identity and purity of food.
4. Tolerance for contaminants, preservatives, emulsifiers and other additives.

Agmark Standard:

The word Agmark is derived from the words ' Agricultural Marketing' . It is a standard of quality based on the physical and chemical characteristics of food, both the natural and those acquired during processing.

Products graded under AGMARK include vegetable oils, ghee, butter, rice, groundnut, pulses and spices. These standards ensure accurate weight and correct selling price.

Bureau of Indian Standards :

The Bureau of Indian Standards lays down criteria for standardisation of vegetables and fruit products, spices and condiments, animal products and processed food.

Manufacturers are allowed to use the BIS label on each unit of their product, if their products conform with the

standards laid down by BIS. The products are checked for quality by laboratories certified by BIS. BIS is also known as ISI (Indian Standard Institution).

Some of the items which require compulsory BIS certification under PFA Act include artificial food colours, natural food colours, food additives, infant formula, milk-cereal based weaning foods, milk powder and condensed milk.

Questions

Part- A

Fill in the blanks:

1. Adulterants that are added deliberately are known as _____ adulterants.
2. The adulterant found in ghee is _____
3. Milk is usually adulterated with _____ and _____
4. The word Agmark is derived from the words _____

Part- B

Write short Answers

1. Define adulteration. What are the type of adulterants ? Differentiate them.
2. List the adulterants found in the following items. Suggest simple methods for detecting the adulterants –
   a) Milk b) Tea c) Sugar d) Honey
3. What is BIS ? Explain its use.

Part-C

Give detailed Answers

1. Under what condition is a food deemed as adulterated according to the PFA Act, 1954. What is the role of the PFA Act ?
2. List at least 10 articles normally adulterated. Name the adulterant and the test for detection.
3. Give a detailed account on food laws and standards.

15. DEVELOPMENT IN FOOD TECHNOLOGY

15.1 FOOD TECHNOLOGY – GENETICALLY MODIFIED FOODS

Bio-technology centres around the microbes and cells taken from plants and animals and their ability to synthesize wide range of valuable substances.

The important area of bio-technology application is the qualitative improvement in foods.

The principle governing genetic engineering is that genetic material which is also known as DNA can be transferred from a cell of one species to another unrelated species to express itself in the recipient cells. This is also known as recombinant DNA technology.

Foods modified through the transfer of genes are known as Genetically Modified Foods (GM Foods).

Advantages of GM Technology :

1. It is much faster and cheaper and allows a greater precision in selecting desirable characteristics when compared to traditional breeding techniques.
2. It gives rise to pest and virus resistant crops.
3. Nutritional improvement-Genes that control desired micro nutrients can be transferred to obtain new crops with increased vitamin and mineral content.

   The introduction of genetically modified crops with increased vitamin and mineral content is of great importance owing to the prevalence of nutrient deficiencies around the world. Iron - rich rice, quality protein-maize, high carotene-sweet potato and micro nutrient rich seeds are some of the outcomes of research in food bio-technology.

In our country genetically modified rice, potatoes and tomatoes are under experimentation. The golden rice with enhancement of vitamin A is an example.

4. Adaptive to harsh conditions – Genetic modification enables crops to grow in harsh conditions like drought and temperature extremes.

15.2 NEUTRACEUTICALS

The word neutraceuticals originates from the word `nutrition' and `pharmaceuticals'. It implies the usage of food as protective drugs or as food supplements.

Food stuffs contain disease preventing phytonutrients. These include terpenes, phytosterols, phenols and theols.

Terpenes :

Terpenes are found in green foods, soya products and grains. Carotenoids and limonoids are the subclass of terpenes. Carrot, tomato, parsley and spinach are rich sources of carotenoids. They are a precursor of vitamin A and also prevent eye diseases.

Limonoids is present mainly in citrus peels and it is an anti-oxidant. It helps in protecting the lung tissue.

Phytosterols :

Yellow vegetables, yam and the seeds of pumpkin are a rich source of phytosterols. They help in the excretion of cholesterol and prevent tumors in the prostrate gland and breast.

Phenols :

They play an important role in preventive medicine. They prevent the damage of tissues and inflammation. Berries, grapes and brinjals are good sources of phenols. Flavonids, anthocyanidines and isoflavones are important sub classes of phenols.

Flavonoids enhance the effectiveness of vitamin C, prevent allergies, tumors, platelet aggregation and reduce chance of oestrogen induced cancers.

Anthocyanidines help in the synthesis of protein collagen while isoflavones present in bean, legumes and soyabeans prevent tumors, breast and prostrate cancer.

Theol :

They are the sulphur containing class of phytonutrients. Garlic, onion, cabbage and turnip contain theols. Garlic and onion contain allyl sulphides which are anti-carcinogenic agents.

They protect against tumors and prevent cardio-vascular disorders. Cabbage and turnip are known to reduce tumors.

15.3 ALGAE AS FOOD

Blue green algae, *Spirulina fusiformis* is used as nutrient dense food. The major protein in spirulina is phycocyanin which is a deep blue colour pigment and about 150 mgs. It is present in 1 gm of spirulina.

Spray dried spirulina is rich in protein, vitamins particularly β-carotene and gamma linolenic acid. One gram spirulina contains carotenoids equivalent to 1 kg of vegetables and yellow fruits.

Gamma linolenic acid of spirulina help in heart disease, premenstrual stress, obesity and arthritis. The composition of spirulina is given in the following table

TABLE 15A

Composition of spray dried spirulina per 100g

Nutrient	Amount
Energy Kcal	346
Carbohydrate g	16
Protein g	65 - 71
Fat g	6.7
Calcium mg	658
Iron mg	47.7
B - Carotene µg	3,20,000
Tocopherol IU	0.73
Folic acid µg	176

Source: Srilakshmi.B (2003) Food Science, New Age International (P) Publishers Ltd, Chennai.

The quality of protein of spirulina is better than cereals and soya proteins. One serving of spirulina is better than one serving of egg or milk in nutritive value.

Spirulina apart from being rich in nutrients contains phytonutrients like gamma linolenic acid, sulpholipids, phycocyanin and antioxidant vitamins.

The pigments present in Spirulina can raise the activity of lymphocytes, increase immunity and prevent certain type of cancers.

15.4 ORGANIC FOODS

Organic foods are environment friendly foods. These are foods produced without artificial fertilizers or pesticides. Animal manure and compost are used as natural fertiliser and the system of crop rotation further enriches the soil.

Pesticides disturb ecological balance. In the place of pesticides, particular insects and fungi are used to control specific pests.

15.5 FUNCTIONAL FOODS

A functional food is any food that has a positive effect on health, physical performance or state of mind beyond the benefit of nutrition.

Foods rich in antioxidants (β - Carotene, Vitamin C and E) protect the body from the detrimental effect of free radicals that cause coronary heart diseases and cancer. β - Carotene is present in green leafy vegetables and yellow-orange coloured fruits and vegetables.

Vegetable oils, dark green leafy vegetables, nuts and whole grains are a good source of vitamin E and help to maintain the integrity of cells and reduce thrombus formation. Citrus fruits, guava and vegetables such as cabbage and drumstick leaves are a good source of Vitamin C.

Hypocholesterolemic agents such as garlic, fenugreek soya protein, guargum in cluster beans and phytochemicals (pigments and flavouring substances in fruits and vegetables) are functional foods as they protect from heart diseases and cancer.

.Herbs and spices such as black pepper, thyme, turmeric have shown to possess anti-oxidant property and are therefore known as functional foods.

Questions

Part A

Fill in the blanks

1. Foods modified through the transfer of genes are known as _____
2. _____ and _____ are a subclass of terpenes
3. _____, _____, _____ Foods produced without the use of artificial fertilizers and pesticides are known as _____ foods.
4. A _____ is any food that has a positive effect on a persons health beyond the benefit of nutrition.

Part B

Write Short answers:

1. Explain the role of genetically modified foods in the prevention of micro nutrient deficiencies.
2. Give the advantages of bio-fortification.
3. What are neutraceuticals ? Explain the benefits of using them.
4. Write a note on algae as food.
5. What are functional foods and organic foods

Part C

Write detailed answers:

Give a detailed account on the recent trends in food technology

16. INTRODUCTION TO NUTRITION SCIENCE

Nature has provided a variety of foods for man to consume and be healthy. We consume food for maintenance of health, growth and to develop greater resistance against infections.

Foods contain substances called nutrients in varying proportions, which are needed for proper growth and maintenance of life processes. Knowledge of the functions of these nutrients and major food sources is necessary for man to formulate a nutritious diet.

16.1 DEFINITION AND HISTORY OF NUTRITION

Nutrition is defined as a science concerned with the role of food and nutrients in the maintenance of health.

Nutrition as defined by Robinson (1982) is " the science of foods and nutrients, their action, interaction and balance in relationship to health and disease, the processes by which the organism ingests, digests, absorbs, transports and utilizes nutrients and disposes of their end product".

Nutrients are the constituents in food that must be supplied to the body in adequate amounts. These include Carbohydrates, Proteins, Fats, Minerals and Vitamins. Nutritional status is the condition of health of the individual as influenced by the utilization of the nutrients.

The science of Nutrition has been developed by using the combined knowledge of the physical and biological sciences. Its application involves the social sciences related to man's behaviour - Psychology, sociology, anthropology and economics.

Until World War I the significance of nutrition was recognized by a relatively small group of scientists and

physicians. Since then, a wider awareness has developed on the role of nutrients in health of individuals and the economic development of the nation.

A great number of important discoveries and developments in this field have enabled health care professionals to understand the nutrient needs of people and the means of supplying them. It is difficult to set in a chronological order of events that show the development of nutrition.

Many aspects developed simultaneously or overlapped each other. Some discoveries went unnoticed for several years because scientific attention was occupied with other developments and theories.

Some progresses were stimulated by national emergencies. Others depended on technical development of the supporting sciences. Nutrition research in India, as beri – beri inquiry was started in 1918, under the guidance of Sir Mc Carrison at Coonoor in South India.

It has blossomed into an important national institution, at Hyderobad called National Institute of Nutrition. It is currently engaged in carrying out basic as well as applied research work in nutrition. This national institute comes under the Indian Council of Medical Research (ICMR).

16.2 RELATION BETWEEN GOOD NUTRITION AND HEALTH

Health is defined by the World Health Organization (WHO) as the " State of complete physical, mental and social well being and not merely the absence of disease or infirmity".

To maintain good health and nutritional status one must eat a balanced food, which contains, all the nutrients in the correct proportion.

The essential requisites of health would include the following:

1. Achievement of optimal growth and development, reflecting the full expression of one' s genetic potential.

2. Maintenance of the structural integrity and functional efficiency of body tissues necessary for an active and productive use.
3. Mental well-being
4. Ability to withstand the inevitable process of aging with minimal disability and functional impairment.
5. Ability to combat diseases such as
   – resisting infections (immunocompetence)
   – preventing the onset of degenerative diseases
   – resisting the effect of environmental toxins/ pollutants

Till three decades ago the role of nutrition in growth and development and tissue integrity alone was clear, but now the persuasive role nutrition plays in the other dimensions of health is implicit. Hence an optimal nutritional status is an indication of good health. This recent advance has brought about a large-scale change in dietary habits and practices of the population.

16.3 CONCEPTS OF MALNUTRITION – UNDER NUTRITION AND OVER NUTRITION

Malnutrition as defined by World Health Organisation (WHO) is a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients, this state being clinically manifested or detected only by biochemical, anthropometric or physiological tests.

Four forms can be distinguished:

a. Undernutrition – the pathological state resulting from the consumption of an inadequate quantity of food over an extended period of time.
b. Marasmus is synonymous with severe undernutrition. Starvation implies total elimination of food and hence the rapid development of under nutrition and marasmus.
c. Specific deficiency – the pathological state resulting from a relative or absolute lack of an individual nutrient.
d. Over nutrition – the pathological state resulting from a disproportion of essential nutrients with or without the

absolute deficiency of any nutrient as determined by the requirement of a balanced diet.

16.4 SIGNS OF A WELL NOURISHED CHILD AS AGAINST THOSE OF AN ILL NOURISHED CHILD

Table 16 A

Sl. No	Signs of well nourished child	Signs of ill nourished child
1.	Skin is smooth, pliable and elastic and of a healthy colour.	Lack of colour of skin – paleness
2.	Bright and clear eyes and pink eye membranes.	Pale, dark red, or purple mucous membrane lining the eyes. Failing eye sight.
3.	Firm pink nails	Rigid brittle nails.
4.	The hair is lustrous and firmly attached to the scalp.	Dull hair lacking sheen, dry, and can be easily plucked.
5.	Healthy gums and membranes of the mouth.	Pale, dark red or purple colour of gums.
6.	Reddish pink tongue. Not coated, pink lips.	Sores on skin, lip or tongue, pale lips.
7.	Desirable height for age and desirable weight for height.	Stunted growth and weight deficit.
8.	Good appetite and sound nutrition.	Loss of appetite, digestive disturbances, undernutrition.
9.	Normal body temperature, pulse rate and breathing rate.	Above normal body temperature, shortness of breath while performing normal activity.
10.	Healthy children are alert.	Listless, irritable and depressed.

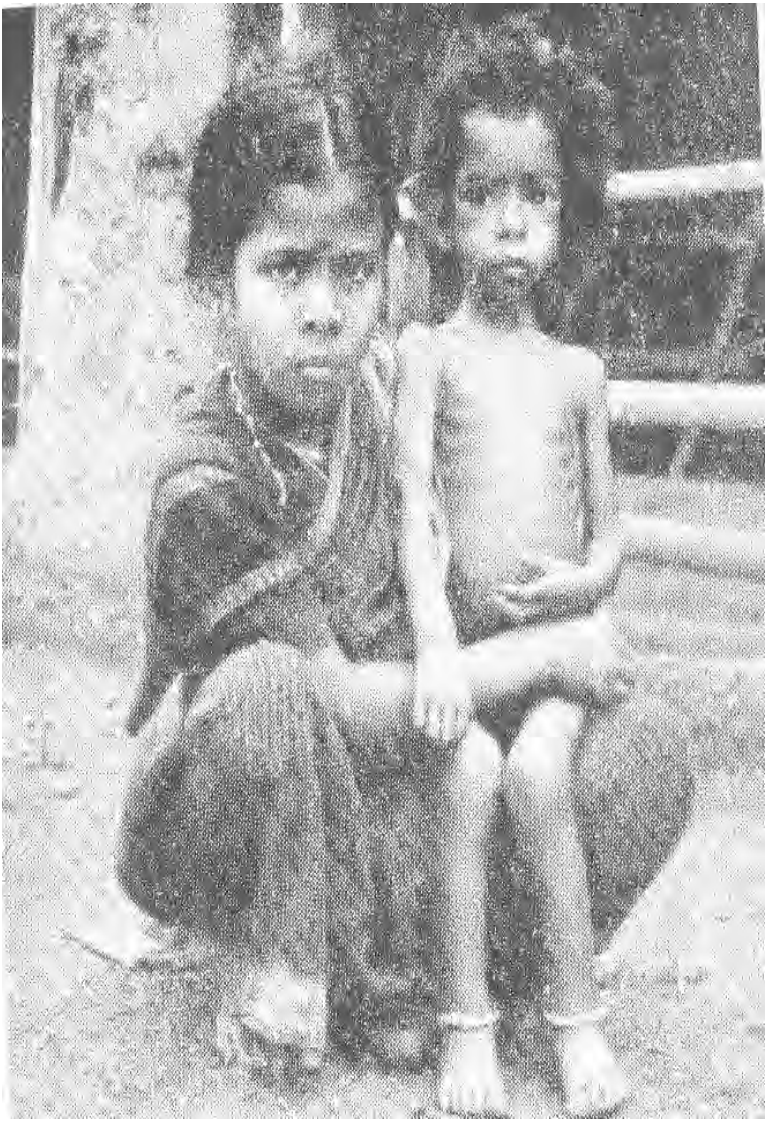


Fig 16.1 An ill nourished Indian child
Source : Human Nutrition: Principles and Applications In India, by Mc Divitt.M.E. and Mudambi S.R., 1973

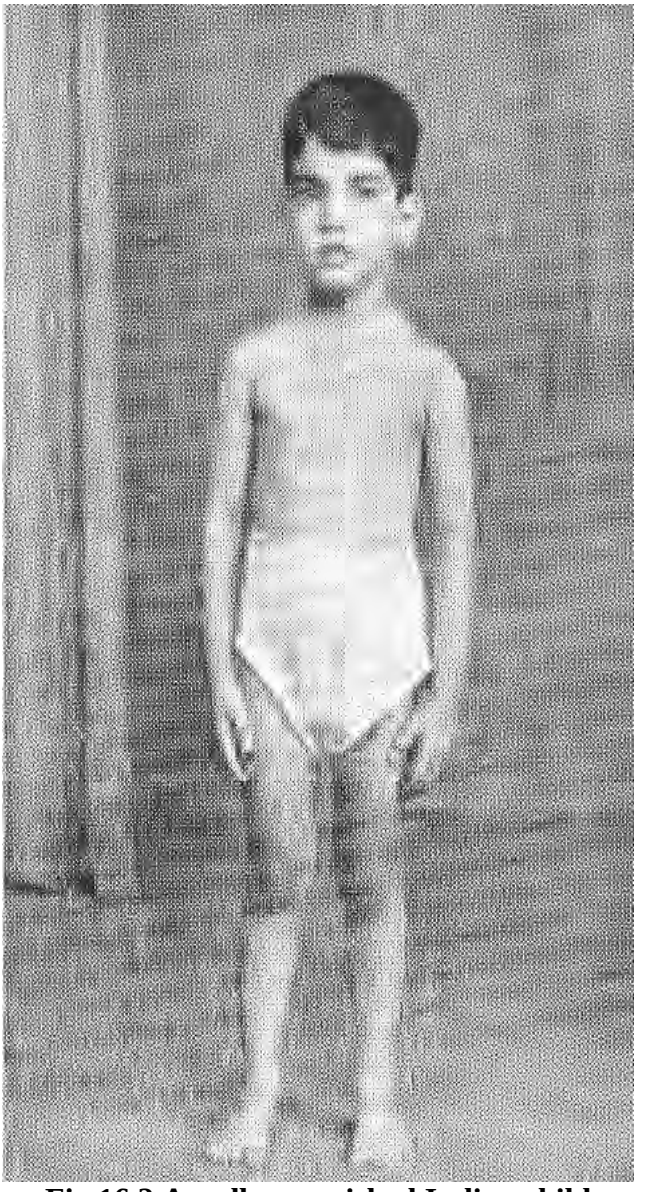


Fig 16.2 A well – nourished Indian child
Source : Human Nutrition: Principles and Applications In India, by McDivitt .M.E.and Mudambi S.R., 1973

16.5 NEED FOR AND METHODS OF ASSESSING NUTRITIONAL STATUS

Nutritional status is the condition of health of the individual as influenced by the utilization of the nutrients. It can be determined by correlation of information obtained through medical and dietary history, thorough physical examination and laboratory investigation.

Nutritional assessment aids in identifying

a) Under Nutrition
b) Over Nutrition
c) Nutritional deficiencies
d) Individuals at the risk of developing malnutrition
e) Individuals at the risk of developing nutritional related diseases
f) The resources available to assist them to overcome nutritional problems.

The nutritional status can be assessed by the following methods:

I Direct Methods

a) Nutritional Anthropometry
b) Clinical Examination
c) Biochemical tests and
d) Biophysical methods.

II Indirect Methods

a) Vital statistics of the community
b) Assessment of socio – economic status and
c) Diet surveys

16.6 ANTHROPOMETRIC MEASUREMENTS AND INDICES

Nutritional Anthropometry is concerned with the measurements of the variations of physical dimensions and body composition at stages of life cycle and different planes of nutrition. It is a field-oriented method, which can be easily adopted and interpreted.

The basic measurements which should be made on all age groups are weight in kg, length / height and arm circumference in cms. In young children it should be supplemented by measurements of head and chest circumference.

Weight:

Weight gain is an indicator of growth in children. It is measured with the help of the weighing scale. Body weight should be determined after the first void and before ingestion of food.

The weight for age can be compared with the standards of ICMR and the nutritional status can be interpreted.

The standard reference body weight (kg) of Indians of different age groups is given in the table 16 B

Table 16 B

Reference body weight (kg) of Indians of different Age groups

Reference body weight (kg)			
	Age (years)	Male	Female
Infants	0 – ½	5.4	5.4
Children	½– 1	8.6	8.6
	1 – 3	12.61	11.81
	4 – 6	19.20	18.69
	7 – 9	27.00	26.75
	10 – 12	35.54	37.91
Adolescents	13 –15	47.88	46.66
	16 – 18	57.28	49.92
Adults	20 – 50	60	50

Source : ICMR 2002. Nutrient Requirements and recommended dietary allowances for Indians. NIN.

Anthropometric Indices : Weight for age The Nutritional status can be interpreted using Gomez Classification as follows

Weight $\geq$ 90% Weight for age. Normal.

76 – 90% Weight for age. Grade I malnutrition.

61 ≤ 75% Weight for age. Grade II malnutrition.

≤ 60% Weight for age. Grade III malnutrition.

Linear Measurements

Two types of linear measurements are commonly used.

(i) height or length of the whole body

(ii) circumference of the head and the chest.

Height :

The height of the individual is the sum of four components: leg, pelvis, spine and skull.

Table 16 C

The Standard Reference height for Indians of different age groups.

Age (years)	Height in cm	
	Boys	Girls
1+	80.07	78.09
2+	90.01	87.93
3+	98.36	96.21
4+	104.70	104.19
5+	113.51	112.24
6+	118.90	117.73
7+	123.32	122.65
8+	127.86	127.22
9+	133.63	133.08
10+	138.45	138.90
11+	143.35	145.00
12+	148.91	150.98
13+	154.94	153.44
14+	161.70	155.04
15+	165.33	155.98
16+	168.40	156.00

Source : ICMR 2002. Nutrient Requirements and recommended dietary allowances for Indians. NIN.

The height of an individual is measured using a stadiometer.

For infants and children recumbent length (crown – heel length) is measured. The measurement is compared with the standards of the ICMR as given in table 16C to assess nutritional status.

The desirable birth weight and length of an infant is 3 kg and 50 cm respectively. By the time the baby turns the first birth day, the birth weight is doubled and an increment of 25 cm in length is reached.

Changes in body weight from birth till one year

Fig 16.3

Head Circumference :

The measurement of head circumference is a standard procedure to detect pathological condition in children. Head circumference is related mainly to brain size. At birth the circumference of head is greater than that of the chest.

Fig 16. 4 Measuring head circumference

Source: Jelliffe, D.B., 1989, The Assessment of Nutritional Status of the community WHO Monograph Series, Geneva

Chest Circumference :

The circumference of the head and the chest are about the same at six months of age. After this the skull grows slowly and the chest more rapidly.

Therefore between the ages of six months and five years the chest / head circumference ratio of less than one may be due to failure to develop or due to wasting of muscle and fat of chest.

In nutritional anthropomertry the chest / head circumference ratio is of value in detecting under nutrition in early childhood.

Fig.16.5 Measuring chest circumference

Source: Jelliffe, D.B., 1989, The Assessment of Nutritional Status of the community WHO Monograph Series, Geneva

Mid Upper Arm Circumference (MUAC) :

Mid upper arm circumference at birth in a healthy child is between 10 – 11cm. over the first year the increment in MUAC is 3 to 4 cm as the muscles of the arms start to develop. In the preschool age the increase in MUAC is only one cm. Hence there is not much difference between the MUAC of a 3 year old from that of a 5 year old. So MUAC is an age independent index. The field workers in nutrition in our country have fixed the desirable value for MUAC as 12 cm for Indian preschool children.

The WHO has recommended 14 centimeter as a desirable value for MUAC for preschool children.

Hence in screening malnourished children in a community this method is used with ease. When the value of

MUAC is less than 12 cm among 1 –5 year old children, they are designated as malnourished.

In the field condition a bangle with a diameter of 4 centimeter can be used as a tool to detect malnutrition. When the bangle moves smoothly over the mid-upper arm of the child, it indicates malnutrition. The bangle test can be conducted with ease in field condition to screen malnourished children.

Fig. 16.6 Measuring mid upper arm circumference
Source: Jelliffe, D.B., 1989, The Assessment of Nutritional Status of the community WHO Monograph Series, Geneva

16.7 CLINICAL SIGNS OF NUTRITIONAL DEFICIENCY DISORDERS

Clinical examination is an important practical method for assessing the nutritional status of a community. Essentially, the method is based on examination for changes, believed to be related to inadequate nutrition that can be seen or felt in the superficial epithelial tissues especially the skin, eyes, hair and buccal mucosa or in organs near the surface of the body such as the parotid and thyroid glands.

Clinical assessment must always be carried out by individuals with adequate training. The following simple guide is employed to interpret the following deficiencies.

Guide for the interpretation of deficiencies and identifying the clinical signs.

	Condition		Clinical Signs
(i)	Protein Energy Malnutrition	:	Odema, depigmentation, sparseness and easy pluckability of hair, moon face, enlarged liver, muscle wasting.
(ii)	Vitamin A deficiency	:	Night blindness, Bitot's spots in the eye, Xerosis of skin.
(iii)	Riboflavin deficiency	:	Angular stomatitis, cheilosis.
(iv)	Thiamine deficiency	:	Oedema, sensory loss, calf muscle tenderness.
(v)	Niacin deficiency	:	Raw tongue, pigmentation of the skin.
(vi)	Vitamin C deficiency	:	Spongy and bleeding gum.
(vii)	Vitamin D deficiency	:	Rickets, beading of ribs, Knock – knees, bowed legs.
(viii)	Iron deficiency	:	Pale conjunctiva, spoon – shaped nails.
(ix)	Iodine deficiency	:	Enlargement of thyroid gland.

Source: Jelliffe, D.B., 1989, The Assessment of Nutritional Status of the community WHO Monograph Series, Geneva

Biophysical Methods:

The biophysical methods are used to assess the alterations in functions associated with inadequate nutrition. For (eg) Dark adaptation test is used to evaluate the ability to see in the dim light.

Biochemical test:

Biochemical tests can be used to detect the deficiencies by analyzing blood, urine, stools and phlem. For (eg) Estimation of hemoglobin in blood to detect iron deficiency.

Indirect Methods:

Vital Statistics:

Malnutrition influences morbidity, mortality, life expectancy and other health statistics. Hence vital statistics may therefore be considered as indirect indication of the nutritional status of the community.

Infant mortality rate, maternal mortality rate and morbidity rate are the vital statistics that can be used to assess the nutritional status of the community.

Assessment of socio – economic status: -

Low food availability, increased family size, unsanitary living conditions, inadequate knowledge of nutritional needs, inappropriate weaning practices are powerful social cultural and economic factors, which influence nutritional status.

Diet surveys:

Diet surveys are helpful in studying the quality and quantity of food consumed by the family and the community. The techniques of collecting information on family food consumption include:

1) **Food Inventory Method:** This method is usually employed in Institutions where homogenous group of people take their meals in a common kitchen eg. Hostels, orphanages. In this method the amount of food stuff issued to the kitchen as per the issue register

is taken into consideration. No direct measurement or weighing is done. A study period of one week is desirable.

2) Food expenditure pattern method

In this method information on the amount spent on food and non-food items during the previous month or week is collected using a questionnaire. This method avoids actual weighing of foods.

3) 24 hour recall

In this method a set of standardized cups suited to local conditions are used. The standard cups help the respondent to recall the quantities of the food prepared and fed to individual members on the previous day. This is usually done for three consecutive days. The advantage of this method is that the intake of each food item by the specific individual in the family such as pre-school child, adolescent, pregnant women can be assessed using the cups.

4) Diet History:

This method is useful for obtaining qualitative details of diet and studying patterns of food consumption at household and industrial level. The procedure includes assessment of the frequency of consumption, different foods, daily or number of times in a week or fortnight or occasionally. This method is used to study meal pattern, dietary habits, food preferences, and avoidances during sickness.

5) Weighment method:

In this method, the food either raw or cooked is actually weighed using an accurate balance. It is ideal to conduct the survey for seven consecutive days. Every day food is weighed in the morning and evening before actual cooking. The age, sex, physiological status of the family members should be noted down. Nutrient intake is then calculated using the ICMR food

composition tables. Though this method is accurate as the foods are directly weighed, it requires extreme co-operation of the house wives.

The information on food and nutrient consumption is compared with the recommended allowances of the ICMR and the adequacy is determined. A combination of dietary, clinical and biochemical assessment is desirable for assessment of nutrition status of individuals or communities.

Questions

Part-A

Fill in the blanks:

1. Good nutrition is required to maintain _____
2. _____ is impairment of health resulting from deficiency, excess or imbalance of nutrients.
3. Diet survey is an _____ of assessing the nutritional status of the community.

Part-B

Write short answers:

1. Define nutrition, nutritional status and health.
2. Explain what is mal nutrition?
3. How will you differentiate between a well-nourished and ill nourished child?

Part-C

Write detailed answers:

How will you assess the nutritional status of your class using nutritional anthropometry methods?

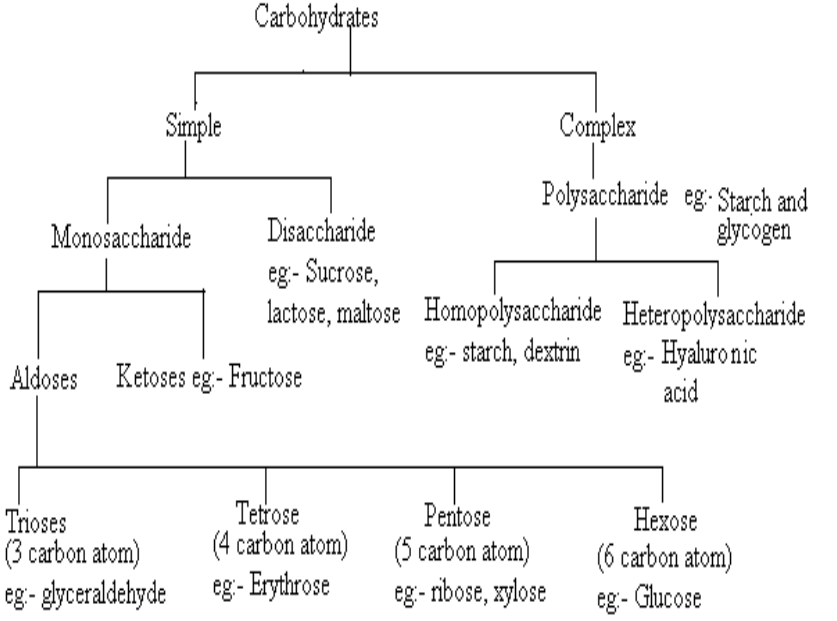
17. CARBOHYDRATES

Energy that is needed to move, perform work and live is chiefly consumed in the form of carbohydrates. Carbohydrates, primarily starches, are least expensive, easily obtained and readily digested form of fuel.

17.1 COMPOSITION

Carbohydrates are organic compounds composed of carbon, hydrogen and oxygen, with the later elements in the ratio of 2:1. The general formula is $C_nH_{2n}O_n$. They are viewed as hydrated carbon atoms.

17.2 CLASSIFICATION – SIMPLE AND COMPLEX :



Carbohydrates are classified, depending on the number of sugar units they contain, as simple carbohydrate and complex carbohydrates.

Monosaccharides and disaccharides make up simple carbohydrates, called simple sugars containing one and two sugar units respectively. Polysaccharides called complex carbohydrates are structurally larger and more complex than simple sugars. They include starch, dietary fibre and glycogen.

There are two main classes of monosaccharides based on the carbonyl group present in them. They are aldoses and ketoses, aldoses (eg; glucose) containing the aldehyde group (CHO) and ketoses, (eg;- fructose) containing the ketone group (C=O).

Aldoses are further divided into trioses, tetroses, pentoses and hexoses based on the number of carbon atoms.

The common disaccharides are Maltose, Lactose and Sucrose which on hydrolysis yield two monosaccharide units.

Maltose $\xrightarrow{\text{hydrolysis}}$ Glucose + Glucose

Lactose $\xrightarrow{\text{hydrolysis}}$ Glucose + Galactose

Sucrose $\xrightarrow{\text{hydrolysis}}$ Glucose + Fructose

Polysaccharides have high molecular weight and are insoluble in water. They are in the form of long chains either branched or unbranched.

The polysaccharides are further classified into groups depending upon the products they yield on hydrolysis. Homopolysaccharides yield only one type of monosaccharide units on hydrolysis eg:- starch, dextrin, cellulose, glycogen.

Heteropolysaccharides yield more than one type of monosaccharide units on hydrolysis eg:- Heparin, Hyaluronic acid. Heparin is an anticoagulant found in the liver, spleen, lungs and blood. Hyaluronic acid is found in the umbilical cord,

synovial fluid and vitreous humour. It has a lubricating action. In tissues it forms an important part of the cementing ground substance.

The sugars are also classified as reducing and non reducing sugar. The reducing property is attributed to the free aldehyde or keto group.

17.3 FUNCTIONS AND FOOD SOURCES

Carbohydrates perform the following functions.

1. Energy :

The principle function of carbohydrates is to serve as a major source of energy for the body. Each gram of carbohydrate yields 4Kcal of energy regardless of its source. In Indian diets 60 – 80 % of energy is derived from carbohydrate.

2. Glucose:

Glucose is indispensable for the maintenance of the functional integrity of the nervous tissue and is the sole source of energy for the proper functioning of the brain.

Prolonged lack of glucose may cause irreversible damage to the brain.

3. Protein Sparing Action :

Carbohydrates exert a protein sparing action. If sufficient amounts of carbohydrates are not available in the diet, the body will convert protein to glucose in order to supply energy.

Hence to spare proteins for tissue building, carbohydrates must be supplied in optimum amounts in the diet. This is called the protein sparing action of carbohydrates.

4. Fat Metabolism :

Carbohydrates are essential to maintain normal fat metabolism.

Insufficient carbohydrates in the diet results in larger amounts of fat being used for energy than the body is equipped

to handle. This leads to accumulation of acidic intermediate products called ketone bodies.

5. Synthesis of Body Substances

Carbohydrates aid in the synthesis of nonessential aminoacids, glycoproteins (which function as antibodies) and glycolipids (which form a part of cell membrane in body tissues especially brain and nervous system).

Lactose remains in the intestine longer than other disaccharides and thus encourages growth of beneficial bacteria.

6. Precursors of Nucleic Acid :

Carbohydrates and products derived from them, serve as precursors of compounds like nucleic acids, connective tissue matrix and galactosides of nervous tissue.

7. Detoxification Function :

Glucuronic acid, a metabolite of glucose serves as a detoxifying agent.

It combines with harmful substances containing alcohol or phenolic group converting them to harmless compounds which are later excreted.

8. Roughage of the Diet :

Insoluble fibres known as composite carbohydrates can absorb water and give bulk to the intestinal contents which aids in the elimination of waste products by stimulating peristaltic movements of the gastrointestinal tract.

Food Sources of Carbohydrates

Cereal grains, roots and tubers are the major sources of starch. Fruits and vegetables contain varying amounts of monosaccharides and dissaccharides.

Sugar is obtained from sugarcane.

Types and sources of Carbohydrates are given in the table-17A.

Table 17A
Types and Sources of Carbohydrates

Carbohydrate	Food Source
1. Monosaccharides	
Glucose	Fruits, honey, corn-syrup.
Fructose	Fruits, honey.
Galactose, Maltose	These do not occur in free form in foods.
2. Dissaccharides	
Sucrose	Cane and beet sugar.
Lactose	Milk and milk products.
Maltose	Malt and Cereal products.
3. Polysaccharides	
Digestible:	
Starch & Dextin	Grains, vegetables especially roots& tubers and legumes
Glycogen	Meat products and seafoods
Indigestible:	Stalks and leaves of
Cellulose	vegetables, outer coat of seeds
Pectins, Gums	Fruits, Plant secretions and seeds.

17.4 DIGESTION, ABSORPTION AND UTILIZATION

Digestion :

The first stage of digestion of carbohydrate takes place in the mouth. Chewing breaks up food and exposes starch and sugars to the action of enzymes.

Saliva contains salivary amylase (ptyalin). It converts starch to maltose but time limits the action of salivary amylase, because as food enters the stomach, the acid present in the stomach blocks the action of salivary amylase.

In the stomach the acid causes hydrolysis of sucrose. In the small intestine pancreatic amylase and intestinal amylase digest starch up to the stage of maltose.

Starch $\xrightarrow[\text{\& intestinal amylase}]{\text{salivary, pancreatic}}$ maltose + Isomaltose

Glycogen is also broken by these enzymes to dissacharides. Enzymes maltase, sucrase and lactase present in the brush borders of the columnar cells of small intestine convert dissacharides to monosaccharides.

Maltose $\xrightarrow{\text{Maltase}}$ Glucose + Glucose

Lactose $\xrightarrow{\text{Lactase}}$ Glucose + Galactose

Sucrose $\xrightarrow{\text{Sucrase}}$ Glucose + Fructose

Cellulose and other polysaccharides are not digested by enzymes, so undigested material passes to large intestine forming bulk which contributes to faeces.

The end products of carbohydrate digestion are monosaccharides – glucose, galactose and fructose.

They are absorbed by process of active absorption by the mucosa of the small intestine.

Metabolism:

Metabolism occurs inside the various cells of the body. There are two types of metabolism; anabolism (building up) and catabolism (breaking down).

The major carbohydrate anabolic path ways are conversion of glucose into glycogen (glycogenesis) in the liver and muscles. The conversion of glucose into fat (lipogenesis) in the liver and adipose tissue.

Carbohydrates follow two major catabolic pathways:

The breakdown of glucose releasing energy (glycolysis) and converting it into usable energy (ATP) and the conversion of glycogen to glucose (glycogenolysis).

After digestion and absorption of glucose into the blood stream it is utilized directly by the tissues for energy.

When the absorbed glucose exceeds the body' s need for energy it is stored as glycogen in the liver and muscle and excess glucose is converted to triglycerides and stored as fat in adipose tissue.

17.5 REQUIREMENTS

As carbohydrate is utilized as main source of energy, at least 40 percent of the total energy in the food should come from Carbohydrates.

In our country 60 – 80 percent of a day' s energy needs are met from carbohydrates in the form of starch furnished by cereals and pulses.

In developed countries only 30 – 40 percent of days energy needs are met from carbohydrates.

17.6 DIETARY FIBRE

Dietary fibre is defined as that portion of plant material ingested in the diet that is resistant to digestion by gastro intestinal secretions. It consists of hemicellulose, cellulose, lignins, oligosaccharides, pectins, gums and waxes.

Some bacteria in the large intestine can degrade some components of fibre releasing products, that can be absorbed into the body and used as energy source.

Two categories of fibre are found in food. Crude fibre is defined as the residue remaining after the treatment with hot sulphuric acid, alkali and alcohol.

The major component of crude fibre is a polysaccharide called cellulose. Crude fibre is a component of dietary fibre. Several other carbohydrate and related compounds called pectins, hemicellulose and lignins are the second category found in plant foods and are also resistant to digestion.

These together with cellulose are collectively known as dietary fibre.

Types of fibre:

There are two types of fibre – soluble and insoluble fibres. The food source and action of these in the body is given in the table-17B.

Table 17 B

Types and Sources of fibre.

Types of fibre	**Major food sources**	**Action in the body**
Soluble fibres Gums, pectins, mucilages	Citrus fruits, apple, oats, barley, legumes	• Delay gastro intestinal transit • Delay glucose absorption • Lower blood cholesterol
Insoluble fibres Cellulose hemicellulose Lignin	Whole wheat products, wheat bran, whole grain breads, cereals and vegetables like green peas, beans cabbage. Skin of vegetable and fruits, grains	• Accelerate Gastro intestinal transit • Increase fecal weight • Slow starch hydrolysis • Delay glucose absorption

Questions

Part A

Fill in the blanks:

1) Formation of glycogen from non carbohydrate sources is called _____

2) Extra calories from glucose are deposited in the body as _____
3) The starch splitting enzyme is _____
4) Saliva contains the enzyme _____ which acts up on starch
5) The hormone _____ secreted by the cells of islets of langerhans helps in the utilization of sugar by the tissues.

Part B

Write short answers:

1) What are amylases ?
2) State three good sources of cellulose.
3) Give examples of two disaccharides and their source in diet.
4) List the functions of carbohydrates.

Part C

Write detailed answers:

1) Describe the digestion of carbohydrates.
2) Classify Carbohydrates. Write in detail about the main properties of various classes of Carbohydrates.

18. PROTEIN

One fifth of an adults total body weight is protein. Protein is found in every cell of our body.

All the tissues in our body such as muscle, blood, bone, skin and hair are made up of proteins.

Many hormones and enzymes are either protein or protein derivatives. The nucleic acids in the cell nucleus occur in combination with proteins as nucleoproteins.

Protein is thus essential to maintain cellular integrity and function and for health and reproduction.

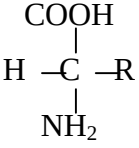
18.1 COMPOSITION

Proteins contain carbon, hydrogen, oxygen and nitrogen. They are distinguished from carbohydrates and fats by the presence of nitrogen.

Protein is synthesized from basic units called amino acids. Protein molecules, which contain up to hundred amino acids are much larger than carbohydrates or lipid molecule.

Chemically amino acids are composed of a carbon atom to which is attached a carboxyl (COOH) group, a hydrogen atom (H), an amino group (NH_2) and an amino acid radical (R) as shown below.

Structure of an Amino acid.



The carboxyl group, the amino group and the hydrogen atom are the same for all amino acids.

The R group however distinguishes one amino acid from another.

R varies from a single hydrogen atom as found in glycine, to longer chain of up to 7 carbon atoms.

A protein molecule is made upon of chains of amino acids joined to each other by a peptide linkage. The amino group of one amino acid is linked to the carboxyl group of another amino acid by removal of water.

Thus two amino acids form di-peptide and three form a tri-peptide. Proteins consist of hundreds of such linkages hence called Polypeptides.

18.2 ESSENTIAL AND NON-ESSENTIAL AMINO ACIDS

Amino acids are classified into two groups – essential (indispensable) and non-essential (dispensable).

An essential amino acid is one that cannot be synthesized by the body to meet the physiological needs and hence should be supplied by the diet. The essential amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine threonine, tryptophan and valine. Non-essential amino acids are those that the body can synthesize. They are alanine, arginine, aspargine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine and tyrosine.

18.3 BIOLOGICAL VALUE OF PROTEIN

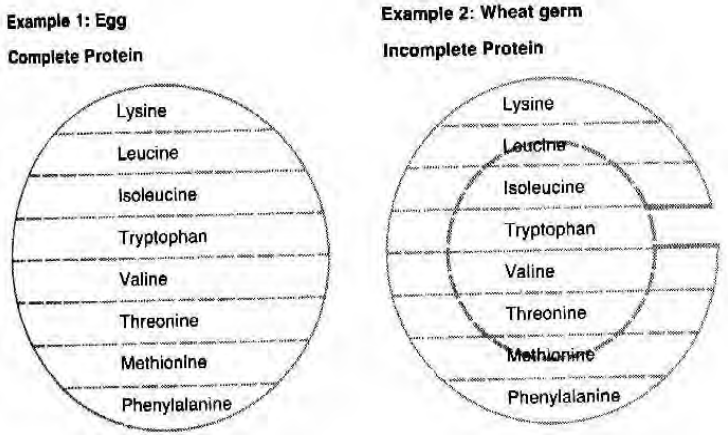
Biological value of protein is the percentage of a protein nitrogen that is absorbed and available for use by the body for growth and maintenance.

Proteins are functionally divided into complete, partially complete and incomplete proteins. A complete protein contains all essential amino acids in relatively the same amounts as human beings require to promote and maintain normal growth. (eg) Protein derived from animal foods. A partially complete protein contains sufficient amounts of amino acids to maintain life but fail to promote growth. (eg) Gliadin in wheat. Incomplete proteins are incapable of replacing or building new

tissue and cannot support life or growth. (eg) Protein in Wheat germ.

The quality of a protein is determined by the kind and proportion of amino acid it contains. Proteins that contain all essential amino acids in proportions capable of promoting growth are described as complete protein, good quality protein, or proteins of high biological value.

A good quality protein is digested and utilized well. Egg protein is a complete protein and is considered as a reference protein with the highest biological value. The quality of other proteins is determined based on their comparison with egg protein as in figure 18.1



The eight essential amino acids (EAA) must be present in a protein in specific ratios. Egg protein has all eight in the correct proportions used most efficiently and completely by the body.

Wheat germ is an incomplete protein because it is deficient in tryptophan (incomplete circle). As a result of this deficiency only less of the total protein can be used (as represented by the inner dotted circle).

Fig.18.1 Comparison of complete protein with incomplete protein

The protein of animal foods like milk, meat, and fish generally compare well with egg in the essential amino acid composition and are categorized as good quality proteins.

Plant proteins are of poor quality, since the essential amino acid composition is not well balanced.

The amino acid, which is not present in sufficient amount in food protein, is called the limiting amino acid of that food. For (eg) Lysine in cereal protein, Tryptophan in Wheat germ.

Table 18 A

Biological value of food proteins.

	Food Stuff	**Biological Value**
I	Animal Protein	
	Egg	96
	Milk	90
	Meat	74
	Fish	80
II	Vegetable Protein	
	Cereals	
	Rice	80
	Wheat	66
	Maize	50
III	Pulses	
	Bengal gram	74
	Red gram	72
IV	Oil Seeds	
	Ground nut	55
	Gingelly	62

Source: Gopalan.C, B.V.Rama Sastri and Balasubramaniam. S.C.1996 (reprinted) Nutritive Value of Indian foods, NIN. Hyderabad.

The limitation in cereals can be overcome by a judicious combination with pulses, which are rich in lysine.

The resulting mixture of cereals and pulse will have an amino acid pattern better than either of the constituents. Thus a combination of cereal and pulse has a supplementary effect. For (eg) recipes like, Pongal, Idli, dhokla are based on cereal pulse combination.

Thus the habitual diets in India based on cereal and pulse have indeed a rational basis. The biological value of some important food proteins is given in table-18A.

18.4 FOOD SOURCES

All foods except refined sugar, oils and fats contain protein to varying degree.

Table 18 B
Food Sources of Dietary Protein

Food Stuff	**Protein %**
Rich Sources :	
Meat, fish and liver	18 – 20
Eggs	14
Milk powder, full fat	26
Milk powder, skimmed	33
Cheese	18 – 20
Pulses	18 – 24
Nuts and oilseeds	18 – 26
Soyabean	35 – 40
Good Sources :	
Cereals and millets	6 – 12
Tender legumes, green peas, cow peas	7 – 8
Fair Sources :	
Potato	2
Green leafy vegetables	2 – 6

Source : Swaminathan. M. 1986. Principles of Nutrition and Dietetics.

Animal foods like meat, fish, egg and plant foods like pulses oilseeds and nuts contain high amounts of proteins and are classified as rich sources of proteins.

Cereals and millets and tender legumes such as green peas are moderate sources of protein.

However cereals are consumed in large amounts daily and contribute a considerable amount of protein to the daily intake.

Leafy vegetables, roots and tubers are poor sources of protein as they contain less than two percent proteins.

The protein content of foods are listed in the table-18B.

18.5 FUNCTIONS OF PROTEIN

Proteins form a major part of total body structures and they participate in many activities in our body. The major functions of protein in our body can be listed as in the table-18C.

Table 18 C
Functions of Protein

1.	Build and repair body tissues	Proteins form integral parts of most body structure such as skin, tendon, membranes, muscles, organs and bones. They support the growth and repair of body tissues.
2.	Enzymes	(eg) Lipase helps to breakdown fat and sucrase breaks down sugar.
3.	Hormones	Regulate body process.
4.	Antibodies	Inactivate foreign invaders thus protecting the body against disease.
5.	Fluid & electrolyte balance	Proteins help to maintain the volume and composition of body fluids.
6.	Acid-base balance	Proteins help maintain the acid-base balance of the body fluids by acting as buffers.

7.	Energy	Proteins provide fuel for the body's energy needs [4 KCal/gm].
8.	Storage	Proteins help to store iron and copper.
9.	Homeostasis	Proteins maintain normal osmotic balance among body fluids.
10.	Transport proteins (eg) Haemoglobin, lipoprotein	These type of proteins carry nutrients to the tissues. eg lipoprotein carry lipids, haemoglobin transports oxygen.
11.	Contribute to sensory & physical properties of food	Proteins impart colour , flavour, odour and texture to foods.

18.6 DIGESTION, ABSORPTION AND UTILIZATION OF PROTEINS :

Proteins taken in the diet are digested to amino acids in the stomach and small intestine. Gastric juice contains enzymes pepsin which digests protein in acid medium. It hydrolyses proteins to polypeptides.

Dietary Protein $\xrightarrow{\text{Pepsin}}$ Polypeptides

In the small intestine, pancreatic and intestinal juices contain proteolytic enzymes. Pancreatic juice contains trypsin, chymotrypsin and carboxyl peptidase.

They hydrolyse large protein molecule to smaller polypeptide.

Proteins $\xrightarrow[\text{Chymotrypsin}]{\text{Trypsin and}}$ Peptides + Amino acids

Peptides $\xrightarrow[\text{Amino Peptidase}]{\text{Carboxy peptidase}}$ Aminoacids

Intestinal juices contains polypeptidases & dipeptidases which hydrolyse polypeptide & dipeptide to individual amino acids. There are several peptidases acting on different proteins. When undigested protein enter large intestines, bacteria causes nitrification of proteins leading to foul smelling flatus.

Dipeptides —Dipeptidase→ Amino acids

Tripeptides —Tripeptidase→ Amino acids

Proteins are mainly absorbed in the form of amino acids. Amino acids are absorbed by active transport mechanism in the intestinal cells. Sometimes whole protein may be absorbed by the mechanism of pinocytosis.

Absorbed amino acids pass into the portal blood and reach liver where they are converted to proteins. Other amino acids are transported through general circulation and are utilized for protein synthesis in the tissues.

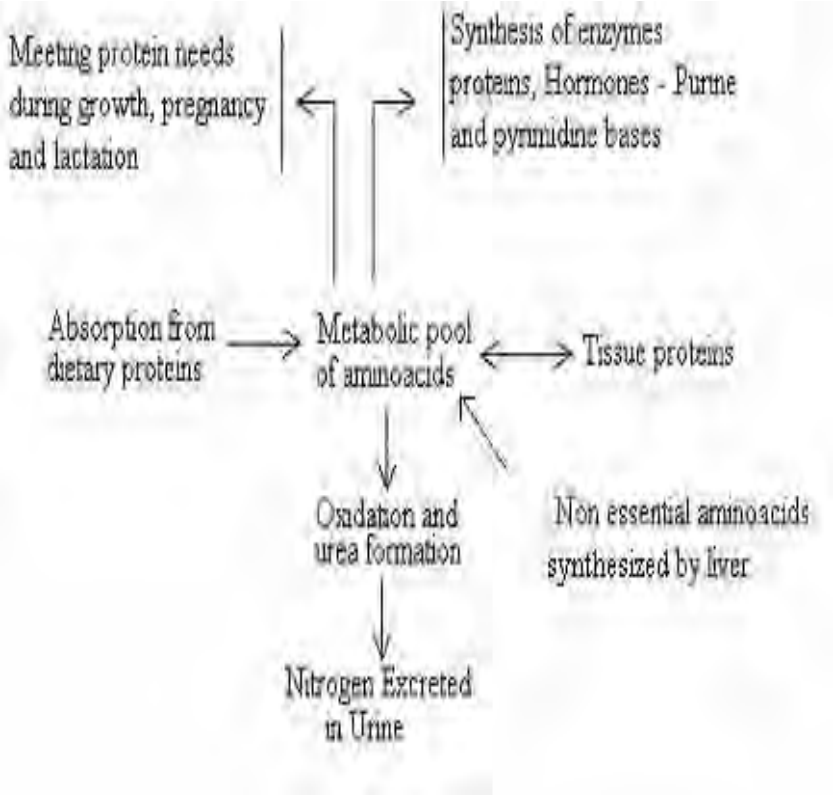
Utilization of proteins in the body :

The amino acids from digested proteins are absorbed rapidly into the blood and passed onto different tissues to meet their needs.

Some non-essential amino acids are synthesized in the liver and also released into the circulation. The amino acids released by hydrolysis of tissue proteins are also added to the amino acid pool in the body.

The protein metabolism of mammals is in a dynamic state and the synthesis and breakdown of tissue protein takes place constantly.

The unwanted amino acids are oxidized in the liver to yield energy and urea. The dynamic aspects of protein metabolism are represented as follows.



Dynamic aspects of Protein Metabolism

18.7 REQUIREMENTS

The Indian Council of Medical Research recommends 1.0 g/kg/day as the safe level of intake in terms of dietary protein for Indians.

During pregnancy and lactation additional allowances are recommended. Protein requirements for children vary depending on body weight and expected weight gain.

The ICMR recommended dietary allowances for proteins is given in table-18D.

Table 18 D
ICMR Recommended Dietary Allowances for Proteins

Group	Protein g/day
Man	60
Woman	50
Pregnant woman	50 + 15
LACTATION	
0-6 months	50 + 25
6-12 months	50 + 18
INFANCY	
0-6 months	2.05 /kg
6-12 months	1.65 /kg
CHILDREN	
1-3 Yrs	22
4-6 Yrs	30
7-9 Yrs	41
BOYS	
10-12 Yrs	54
13-15 Yrs	70
16-18 Yrs	78
GIRLS	
10-12 Yrs	57
13-15 Yrs	65
16-18 Yrs	63

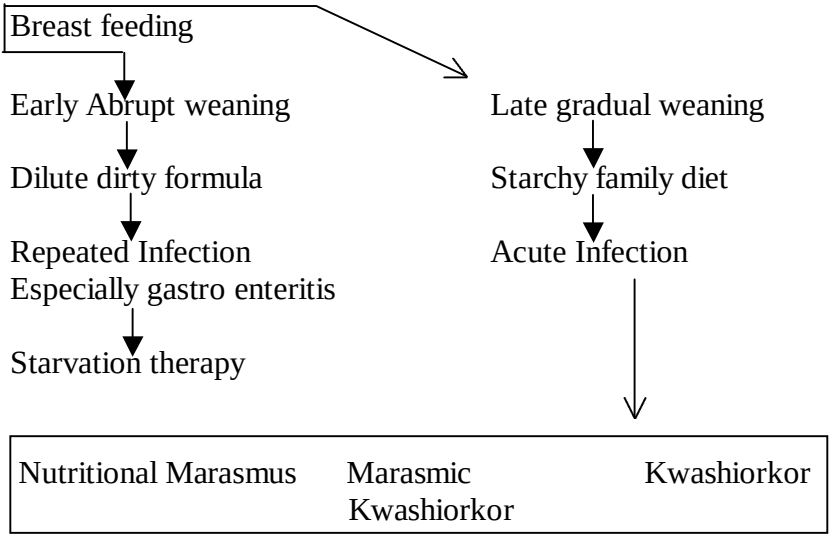
18.8 EFFECTS OF DEFICIENCY

Deficiency of energy and protein commonly occur in developing countries like India. This is manifested as Marasmus and Kwashiorkor. Protein Energy Malnutrition (PEM) is a term used to describe clinical disorders resulting from varying degrees of protein and energy deficiency.

Kwashiorkor is due to quantitative and qualitative deficiency of protein in diet in which energy intake is adequate. Marasmus is due to continued restriction of energy intake.

PEM is prevalent in all parts of the World and in all ages. It is primarily a disease that occurs in young children who live in poverty. In India PEM is the most widespread form of malnutrition among pre-school children. A majority of them suffer from varying grades of malnutrition.

As many as 43.8 percent of pre-school children suffer from moderate degrees of PEM and 8.7 percent suffer from extreme forms of malnutrition. The paths leading from early weaning to Nutritional marasmus and from protracted breast feeding to kwashiorkor is depicted below.



Source : Passmore. R. and Eastwood. M.A1990. Human Nutrition and Dietetics.

Clinical symptoms of Protein Energy Malnutrition

1) Failure to grow accompanied by thinning, weakening and wasting of muscles.
2) Behavioural changes ranging from the irritability of kwashiorkor to the apathy of marasmus.

3) Oedema which is the accumulation of fluid in the tissues making them soft and spongy.
4) Skin changes including changes in colour, lack of colour, peeling and ulceration.
5) Changes in hair which becomes dry and sparse and takes on a characteristic red color (Flags syndrome).
6) Loss of appetite, Vomitting, diarrhoea resulting in dehydration.
7) Enlargement of the liver.
8) Anaemia
9) Increased susceptibility to infection and fever.

Fig 18.2 Marasmic child

Source : Venkatachalam.P.S and Rebello.R.M. 1996 Nutrition for Mother and Child. NIN; ICMR.

Fig 18.3 A child with Kwashiorkor

Source : Venkatachalam.P.S and Rebello.R.M. 1996 Nutrition for Mother and Child. NIN; ICMR.

Fig 18.4 A child after 12 weeks of treatment

Source : Venkatachalam.P.S and Rebello.R.M. 1996 Nutrition for Mother and Child. NIN; ICMR.

Questions

Part A

Fill in the blanks:

1. Proteins are distinguished from Carbohydrate and fat by the presence of _____.
2. Amino acid that cannot be synthesized in the body is called _____.
3. Histidine is a _____ amino acid.
4. _____ protein is the reference protein.
5. Amino acids are linked together by _____linkages.
6. Deficiency of Protein is manifested as _____.

Part B

Write short answers:

1. What are polypeptides ?
2. What are essential and non-essential aminoacids?
3. Explain Limiting aminoacids with an example.
4. How will you determine the protein quality of food?
5. What is reference protein?

Part C

Write detailed answers:

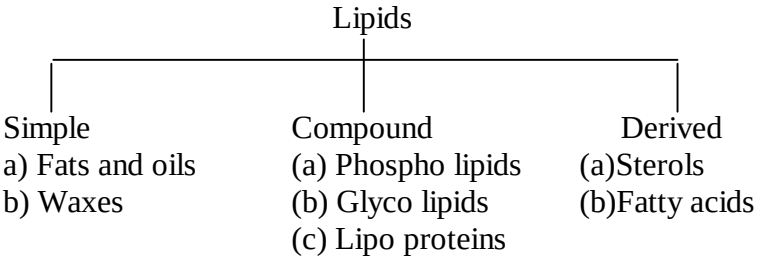
1. Discuss the causes of Kwashiorkor and Marasmus?
2. Discuss proteins under the following heads
   a. Digestion b. Absorption c. Utilization
3. List the functions of protein.

19. LIPID

Lipids more commonly known as fats and oil, are integral part of our food. They are insoluble in water but soluble in organic solvents. They occur in both plant and animals. Lipids are a concentrated source of energy.

19.1 CLASSIFICATION

Lipids are classified into simple, compound and derived lipids which are further subdivided as follows.



Simple lipids

Fats and Oils are included in this type. At room temperature, oils are liquids and fats are solids. Fats and oils contain esters of fatty acid and glycerol, a form in which lipids are present in food.

Compound lipids

They are esters of fatty acids containing phosphorous carbohydrate or protein. Phospholipids contain a phosphoric acid in addition to the alcohol and fatty acids.

Glycolipids contain a fatty acid, carbohydrate and a nitrogenous base. Phospholipids and glycolipids form part of the cell membrane and the nervous system.

Lipoproteins are macromolecular complex of lipids with proteins.

Derived lipids

These are substances liberated during hydrolysis of simple and compound lipids which still retain the properties of lipids. The important members of this group are sterols, fatty acids and alcohol.

Sterols

Sterols are solid alcohols and form esters with fatty acids. In nature they occur in the free state in the form of esters. Based on their origin sterols are classified as cholesterol (animal origin) and phytosterol (in plants).

Cholesterol is a complex type of lipid that is regularly synthesised by and stored in the liver. It is present in all animal products.

Fatty acids

Fatty acids are the main building blocks of fat. They have a methyl group (CH_3) at one end and a carboxyl group (COOH) at the other end with a chain of carbon and hydrogen atom in the middle. They have a basic formula $CH_3(CH_2)$n COOH. Where ' n' denotes the number of carbon atoms which may vary from 2 to 2l.

Fatty acids can be classified into Saturated Fatty Acids(SFA) & Unsaturated Fatty Acids (UFA)

Saturated Fatty Acids

Saturated fatty acids are those that are unable to absorb more hydrogen. They are usually stiff and hard fats. Eg. Ghee, Butter.

Unsaturated fatty acids

Unsaturated fatty acids have one or more double bond in their molecule and are thus not saturated with hydrogen. They are liquid at room temperature. Eg. Sunflower oil.

Unsaturated fatty acids may be monounsaturated or polyunsaturated depending on the number of double bonds.

Monounsaturated fatty acids (MUFA)

MUFA have only one double bond in their molecule. Eg. oleic acid found in olive oil, peanut oil.

Polyunsaturated fatty acids(PUFA)

PUFA have 2 or more double bonds in their molecule. Eg. linoleic acid, linolenic acid. They are present in corn, safflower, soyabean, sunflower oils and fishoils.

Monounsaturated and polyunsaturated fats are usually soft or liquid at room temperature.

Triglycerides

Fatty acids combine with glycerol to form a glyceride, When only one fatty acid combines with glycerol, it forms a monoglyceride, diglycerides have 2 fatty acids and triglycerides have three fatty acids attached to glycerol.

Most of the fatty acids present in the body and absorbed from foods occur in the form of triglycerides.

During digestion triglycerides are hydrolysed to form free fatty acid, monoglycerides and glycerol which are absorbed by the intestinal wall and the majority of these are rebuilt as triglycerides.

Long and short chain fatty acid

The number of carbon atom in fatty acids decides the chain length. Thus short chain fatty acids contain 4 to 6 carbon atoms, medium chain 8 to 12 carbon atoms and long chain fatty acid have 14 to 18 carbon atom.

Essential and Non – Essential fatty acid

Essential fatty acid (EFA) are those which cannot be synthesized by the body and need to be supplied through diet.

Linolenic acid, linoleic acid and arachidonic acid are essential fatty acids.

Non -essential fatty acids

Non-essential fatty acids are those which can be synthesized by the body and which need not be supplied through the diet. Palmitic acid, oleic acid and butyric acid are examples of non – essential fatty acids.

19.2 COMPOSITION

Fat is a complex molecule constituting a mixture of fatty acids and an alcohol, generally glycerol.

It contains carbon, hydrogen and oxygen but differs from carbohydrates in that it contains more carbon and hydrogen and less oxygen.

When one gram of fat is oxidized it yields 9 kilocalories

19.3 FUNCTIONS OF LIPIDS

Lipids perform several important functions:

1) They are the concentrated fuel reserve of the body
2) Lipids are the constituents of cell membrane structure and regulate the membrane permeability.
3) They are essential for the digestion, absorption and utilization of fat soluble vitamins like Vitamin A, D, E and K.
4) Lipids are important as cellular metabolic regulators (Steroid hormones and prostaglandin).
5) Lipids protect the internal organs serving as insulating materials.
6) As compounds of the mitochondria membranes, lipids (phospholipids) participate in electron transport chain.
7) Fat imparts palatability to the diet and slows stomach emptying time, thus giving a feeling of fullness. This delay of onset of hunger is called ' satiety value' of fats.
8) The calories in fat spare the proteins from being oxidized for energy.
9) Fat deposited in the adipose tissue serve as reserve source of energy during starvation. It acts as an insulator conserving the body heat.

Essential fatty acids which are derived lipids, perform important functions in our body.

Functions of essential fatty acids:

1) Maintenance of the function and integrity of cellular and subcellular membrane.
2) Regulation of cholesterol metabolism by transporting it between the blood and body tissues.

3) Acts as precursor of hormone like – prostaglandin which aid in regulating vascular function and help relieving pain and inflammation.
4) Delays blood clotting time.

19.4 DIGESTION ABSORPTION AND UTILIZATION

Digestion

In the mouth:

Fat digestion starts in the mouth with hard fats beginning to melt when they reach body temperature. The salivary glands at the base of the tongue release a lipase enzyme which digest fat to a less extent in adults.

In the stomach:

In the stomach fat floats as a layer above the others components of swallowed food. As a result little fat digestion takes place.

In the small Intestine:

When fat enters the small intestine, the hormone cholescystokinin signals the gall bladder to release bile. Bile emulsifies fat and also provides an alkaline medium for the action of pancreatic lipase and intestinal lipase. The triglycerides are acted upon by these lipases and hydrolyzed to monolycerides and fatty acids.

The cholesterol esters are hydrolyzed to give cholesterol and fatty acids.

Triglycerides ⟶ Monoglyceride + fatty acids
Cholesterol esters ⟶ Cholesterol + fatty acids

Absorption and Utilisation

Small molecules of digested triglycerides (glycerol, short & medium chain fatty acids) can diffuse into intestinal cells and are absorbed directly into the blood stream.

Larger molecules(Monoglycerides, long chain fatty acids) merge into spherical complexes known as miscelles. The lipid contents

of the miscelles diffuse into the intestinal cells. Once inside the monoglycerides and long chain fatty acids are reassembled to new triglycerides.

Within the intestinal cells the new triglycerides and larger lipids like cholesterol and phospholipids are placed into transport vehicle called chylomicrons.

The intestinal cells then release chylomicrons into the lymphatic system. The lymph circulation empties into the thoracic duct which inturn enter the subclavian vein and subsequently into the blood stream.

The blood transport lipids to the rest of the body and cells absorb them and utilize for energy. This breakdown of fat to yield energy is called lipolysis.

Majority of lipids enter via the lymph to the liver where the protein and lipid (cholesterol, triglycerides) are bound together to form lipoproteins.

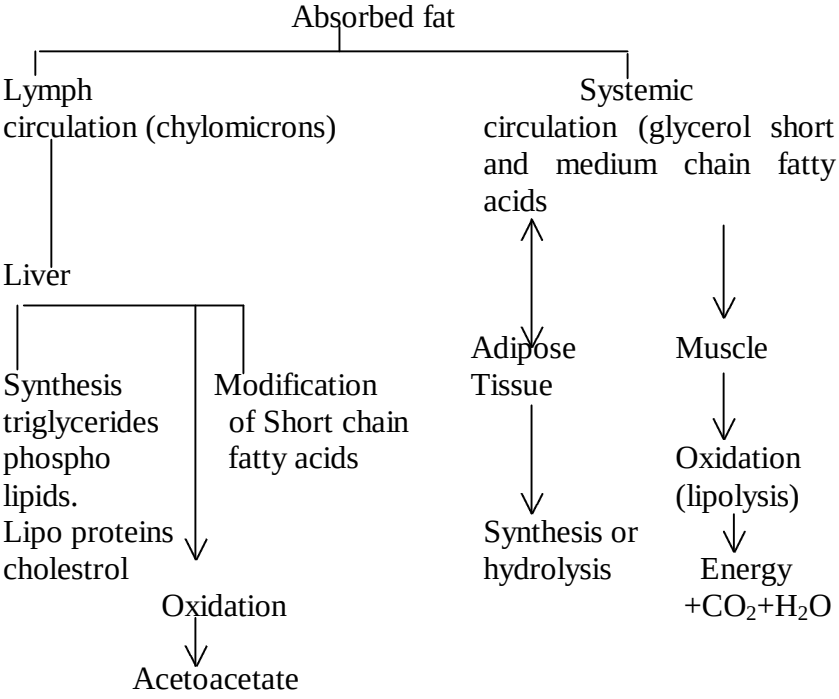
There are four types of lipoproteins, they are:

i) chylomicrons,
ii) very low density lipo protein (VLDL)
iii) low density lipo protein (LDL) and
iv) high density lipo proteins (HDL).

Chylomicrons, VLDL and LDL serve to transport and deposit lipids from the intestine and liver to the tissues for absorption. Low-density lipoprotein, which has the highest cholesterol fraction favours lipid deposition in tissues including blood vessels and hence termed ‘bad’ cholesterol. HDL cholesterol removes the lipids from the tissues and transports it back to liver for disposal, hence it is termed as ‘good cholesterol’. High levels of LDL cholesterol indicates a high risk of cardiovascular disease.

Apart from lipoproteins, triglycerides, cholesterol and phospholipids are synthesized in the liver. This is called lipogenesis.

It can be represented as follows:



Source **:** Robinson C..H., Marilyn. R. and Lawler 1982. Normal and therapeutic nutrition.

19.5 FOOD SOURCES

Foods in general contain two types of fat namely "visible fats" and "invisible" or "hidden" fats.

Visible fats

Visible fats are fats extracted from the following sources.

a. **Oil seeds :** coconut, corn, cornseed, groundnut, mustard, palm, rice bran, safflower, seasame, soyabean, sunflower and hydrogenated vegetable oils (vanaspathi).

b. **Animal fats:** Butter and Ghee.

c. **Fish oils:** Shark and cod liver oils.

Invisible or hidden fats:

Invisible or hidden fats are those which form an integral part of foods and are therefore not visible. It includes the fats present in the cells and cell walls and cell membranes of both plant and animal tissues.

Almost everything we eat as listed below carries some invisible fats.

a) Plant food – Cereals, millets, vegetables, spices, nuts and oil seeds, coconut, avacado.
b) Animal food – Milk and milk products (curd, cream, cheese), flesh foods, (mutton, beef, pork, chicken) organ meats (brain, liver, kidney), fish, shrimp, prawn.

Sources of Saturated Fat:

Saturated fat is resistant to oxidation even at frying temperatures. Examples are

a) Plants – coconut oil. Hydrogenated vegetable oils. Palm kernel oil.
b) Animals – Butter, ghee, fats from flesh foods and organ meats.

Sources of Unsaturated Fat:

Unsaturated fats and oils include mono unsaturated fatty acids and PUFA in various proportions.

Important sources of unsaturated fats are as follows:

Plant sources:

All common vegetable oils with the exception of coconut oils are predominantly unsaturated. The invisible fats present in nuts and oilseeds, cereals, pulses and legumes, roots and tubers, vegetables, spices and fruits.

In most plant foods and vegetable oils linoleic acid is the predominant PUFA, but mustard and soyabean oils, legumes/pulses. Fenugreek leaves, and green leafy vegetables are good sources of alpha linolenic acid.

Animal sources:

The muscles (lean meat) of flesh foods, unlike the depot fat surrounding the tissues is mainly composed of cholesterol

esters and phospholipids, both of which have a high proportion of long chain n-6 PUFA which are otherwise formed in the body from linolenic acid.

Arachidonic acid is found in animal and human cells. Fish and fish oils provide long chain n – 3 PUFA.

Hydrogenation:

Hydrogenation (addition of hydrogen at double bonds) converts liquid oils into semisolid or solid fats. During hydrogenation, linoleic and alpha linolenic acid present in the oils are converted to trans fatty acids and saturated fatty acids. Also, the monounsaturated fatty acids are converted to saturated fatty acids.

Hydrogenated fats were designed to imitate ghee. It is used to prepare processed foods like biscuits and cakes. Vanaspathi is produced in India by hydrogenation of vegetables oils.

Cholesterol:

Cholesterol is a constituent of animal foods but is absent in plants. Vegetable oils do not have cholesterol. In human diets, cholesterol is obtained from ghee, butter, cheese, milk, curd, egg, flesh foods, organ meats, fish and prawns. Most animal foods are good sources of both cholesterol and fatty acids.

Requirements

The ICMR recommended allowances for fat for Indians is given in table 19A.

Table 19 A

The ICMR recommended allowances for fat.

Group	Fat g/day
Adult man	20
Adult woman	20
Pregnant woman	30
Lactating woman	45
Children (1–9 yrs)	25
Children (10–18 yrs)	22

Effects of Deficiency:

Deficiency of fat in the diet causes the deficiency of essential fatty acids. Deficiency of essential fatty acids leads to cessation of growth.

It also results in flaky skin, development of itchy sores on the scalp. The common disorder in adults and children in India is phrynoderma or toad skin.

The condition is characterized by the presence of horny eruptions on the posterior and lateral aspects of the limbs on the back and buttocks.

Phrynoderma is cured rapidly by the administration of linseed or safflower seed oil rich in EFA.

Infants fed on a EFA deficient diet develop irritation and changes in the skin with in a few weeks. The skin changes appear as dryness and desquamation with oozing in the folds.

Diarrhoea may also occur, supplementation of the diet with linoleic acid helps to restore the skin to normal condition.

Questions

Part A

Fill in the blanks:

1. Fats are digested in _____
2. The physiological fuel value of fat is _____
3. Macromolecular complexes of lipids with proteins are called _____
4. _____ is also called the good cholesterol.
5. Fats which form an integral part of food is called _____ fat.
6. One gram of fat when oxidized yields _____ Kcal.
7. Cholesterol and phospholipids are transported via vehicles called _____

Part B

Write short answers:

1. Write short notes on visible and invisible fat.
2. What are essential and non – essential fatty acids.
3. Classify lipids and discuss their properties.
4. Enumerate the functions of essential fatty acids.
5. Write short notes on phrynoderma.

Part C

Write detailed answers:

1. Enumerate the functions of lipids.
2. How is lipid digested, absorbed and utilized in our body.
3. Discuss the various food sources of lipids.

20. ENERGY

Energy is the capacity to do work. The energy to perform work is derived from the carbohydrate, fat and protein in the diet. The source of energy in diets varies depending on agricultural, cultural, social and economic factors.

The body needs energy for maintaining body temperature, metabolic activity, supporting growth, for physical work, to maintain constant body weight and good health.

The body's storage energy or potential energy is continuously available in the body from the glycogen in muscle and liver. This stored energy is transformed to other forms to accomplish the work of the body. Examples are

I. Osmotic Energy – Maintain transport of nutrients.
II. Electrical Energy – Transmission of nerve impulse.
III. Chemical Energy – Synthesis of new compounds.
IV. Thermal Energy – Heat regulation.

Whenever one form of energy is produced another form is reduced by exactly the same amount as stated by the Law of Conservation of Energy.

This law states that energy can neither be created or destroyed it can only be transformed from one form to another.

20.1 UNITS OF ENERGY – CALORIE AND JOULE

The unit of energy, kilocalorie (Kcal) was used for a long time. Recently the International Union of Sciences and International Union of Nutritional Science (IUNS) have adopted 'Joule' as the unit of energy in place of Kcal. These units are defined as follows.

A joule is defined as the energy required to move 1kg mass by 1 metre by a force of 1 Newton acting on it.

One Newton is the force needed to accelerate 1 kg mass by less than a second.

Kcal is defined as the heat required to raise the temperature of 1kg of water by 1° C. (From 14.5°C to 15.5°C)

1Kcal	=	4.184 KJ (Kilo Joules)
1000 Kcal	=	4184 = 4.18 MJ (mega joules)
1 KJ	=	0.239 Kcal.

20.2 ENERGY VALUE OF FOODS

The energy in various foods is measured by calorimetry. Calorimetry is the measurement of heat loss.

An instrument for measuring heat output of the body or the energy value of foods is called a Calorimeter. In measuring the calorie value of foods, Bomb calorimeter is used. The maximum amount of energy that the sample is capable of yielding when it is completely burnt or oxidized is the energy value of that food, also known as heat of combustion.

The energy measured using a Bomb Calorimeter is as follows

1g of Carbohydrate	-	4.1 kcal
1g of fat	-	9.45 kcal
1g of protein	-	5.65 kcal

When samples of Carbohydrate, Fat, Protein are burned, the amount of heat produced is always the same for each of these nutrients.

In the bomb calorimeter carbohydrates, fats and proteins are completely oxidized whereas in the human body the process of digestion and absorption does not proceed with 100 percent efficiency. The extent of digestion varies from one nutrient to another.

The Coefficient of digestibility is used to express the proportion of an ingested nutrient that ultimately becomes available to the body cells.

The coefficient of digestibility for carbohydrate, fat and protein are 0.98, 0.95 and 0.92 respectively. It is observed that carbohydrate and fat are metabolized almost completely,

Whereas protein metabolism is incomplete due to the presence of nitrogen. The physiological energy value of carbohydrate, fat and protein are 4, 9 and 4.

These values are known as Atwater Bryant factors or physiological fuel values as given in table-20A.

Table 20 A
Physiological fuel value of Carbohydrate, Fat, Protein

	Heat of Combustion Kcal	Coefficient of digestibility	Digestibility percent	Physiological fuel value Kcal
Carbohydrate	4.1	0.98	98	4.0
Fat	9.45	0.95	95	9.0
Protein	5.65	0.92	92	4.0

Source : Robinson C. H., Marilyn R. and Lawler. 1982. Normal and Therapeutic Nutrition.

20.3 BASAL METABOLISM

Basal Metabolism is the minimum amount of energy needed by the body for maintenance of life when the person is at post absorptive state, physical and emotional rest.

Basal Metabolic Rate (BMR) is a measure of the energy required by the activities of resting tissue.

The Basal Metabolic rate can be measured directly from the heat produced (using a Respiration Calorimeter and Metabolic Chamber) or indirectly from O_2 intake and CO_2 expenditure when the subject is at rest.

Factors affecting Basal Metabolic Rate (BMR)

The factors affecting Basal Metabolic Rate are listed in table-20B.

Table 20 B
Factors affecting Basal Metabolic Rate (BMR)

Factor	Effect on BMR
Body Compositon	The more lean body mass higher is the BMR. This is due to greater metabolic activity in these tissues when compared to bones and fat. Men with a high proportion of muscle mass or lean body mass have a higher BMR than women.
Fever	Fever raises the BMR. There is a 7% increase in BMR for each degree rise in temperature in Fahrenheit.
Stress	Stress raises BMR.
Smoking & Caffeine	Increases the BMR
Hyperthyroidism (Oversecretion of thyroxin)	The basal metabolic rate is elevated as much as 50-70%.
Growth	In children and pregnant women the BMR is higher.
Pregnancy	During the last trimester of pregnancy Basal Metabolic rate is increased by 15-25% as there is a increase in muscle mass of uterus, size of mammary gland, foetal mass and placenta, cardiac work and respiratory rate.
Fasting/Starvation	Lowers BMR
Hypothyroidism (under secretion of thyroxin)	The basal metabolic rate is decreased by 30%
Age	Lean body mass diminishes with age slowing the BMR. In tall people the BMR is higher.
Undernutrition	Prolonged undernutrition lowers the BMR.

20.4 ENERGY COST OF PHYSICAL ACTIVITIES

Next to Basal Metabolism it is the physical activity, which accounts for the largest energy expenditure.

There is a wide variation from individual to individual in occupational activity.

The energy required for the actual physical activity varies depending on the type of occupation of an individual.

For computing energy requirements, the occupations have been classified as sedentary, moderate and heavy.

The ICMR classification of activities based on occupation is given in table-20C.

Table 20 C

Classification of activities based on occupation

Sex	Sedentary (80-180 Kcal / hr)	Moderate (170-240 Kcal / hr)	Heavy (250-350 Kcal / hr)
Male	1) Teacher 2) Tailor 3) Executive	1) Fisherman, 2) Potter	1) Stone Cutter, 2) Mine Worker. 3) Wood Cutter.
Female	1) Teacher 2) Executive 3) Nurse	1) Servant maid. 2) Weaver	1) Stone Cutter

Source : ICMR 2002 Nutrient requirements and recommended dietary allowances for Indians, NIN

The energy cost of physical activities is expressed in terms of BMR units.

BMR Unit :

The energy cost of rest and physical activity is expressed as multiples of BMR which is called the physical activity ratio (PAR).

The physical activity ratio expresses the energy cost of an individual activity per minute as ratio of the cost of BMR per

minute. Hence it is advantageous to express the energy expenditure in terms of BMR units.

Table 20 D

Energy cost of some common activities in terms of BMR Units.

Activity	Energy cost of activities in BMR Units
Sitting quietly	1.2
Standing quietly	1.4
Sitting at desk	1.3
Walking (3MPH)	3.7

Source : ICMR 2002 Nutrient requirements and recommended dietary allowances for Indians, NIN

Using factorial method the WHO / FAO expert committee has derived the BMR factors for Indian men and women as 1.6, 1.9 & 2.5 respectively for the three categories of activities namely, sedentary, moderate & heavy as given in table-20D.

Table 20 E

Energy requirements of Indian Adults in terms of BMR Units.

Activity	Duration (hrs)	Rate of energy expenditure in terms of BMR Units		
		Sedentary	Moderate	Heavy
Sleep	8	1.0	1.0	1.0
Occupational activity	8	1.7	2.8	4.5
Non-Occupational Activity	8	2.2	2	-
Average for 24 hr		1.6	1.9	2.5

Source : ICMR 2002 Nutrient requirements and recommended dietary allowances for Indians, NIN

20.5 THERMIC EFFECT OF FOOD

Food ingestion stimulates metabolism and requires energy to meet the multiple activities of digestion, absorption and transport of nutrients.

This overall stimulating effect of food is called dietary thermogenesis or thermic effect of food (formerly called as specific dynamic action (SDA). The increase in energy cost because of thermogenesis is 10%.

20.6 ESTIMATION OF TOTAL ENERGY NEEDS

The energy requirement of an individual is the level of energy intake from food that will balance energy expenditure when the individual has a body size and composition and level of physical activity, consistent with long term good health, and that will allow for maintenance of economically necessary and socially desirable activity. In children and pregnant and lactating women, the energy requirement includes the energy needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health. (WHO)

Energy requirements are best determined by measurements of energy expenditure.

Energy expenditure from a physiological point of view is made up of three major components:

(i) BMR (ii) Dietary Thermogenesis (iii) Physical activity

For all practical purposes, the component of energy expenditure related to regulatory energy output or dietary thermogenesis are known to merge into measurements related to the cost of physical activity. Hence energy expenditure has only two principal component i) BMR & ii) Physical activity.

Calculation of energy requirements.

1) Predicting BMR.

Equations for predicting BMR (K.cal / 24 hrs) as proposed by the ICMR expert committee for Indians is given in table-20E.

Table 20 F
Equations for predicting BMR (Kcal / 24 hr)

Sex	Age (yrs)	Prediction Equation
Male	18 – 30	14.5 x B.W (kg) + 645
	30 – 60	10.9 x B.W (kg) + 833
	> 60	12.8 x B.W (kg) + 463
Female	18 – 30	14.0 x B.W (kg) + 471
	30 – 60	8.3 x B.W (kg) + 788
	> 60	10.0 x B.W (kg) + 565

Source : ICMR 2002 Nutrient requirements and recommended dietary allowances for Indians, NIN

2) Calculating Daily energy requirement:

Using the computed BMR from body weights and recommended BMR factor for Indians for different levels of physical activity (which is 1.6, 1.9 & 2.5 for sedentary, moderate & heavy activity respectively) the energy requirements are arrived at.

For example:

For an Indian adult man 29 yrs of age, weighing 60kg and doing moderate activity, the energy requirement is calculated as follows.

1) BMR = 14.5 x 60 + 645 = 1515 k.cal / 24 hr
2) Energy requirement = predicted BMR x BMR units for activity = 1515 x 1.9
   = 2878.5
   2878 k.cal / day.

20.7 ENERGY BALANCE

To maintain daily energy balance the total energy requirement of an individual is the number of K cal necessary to replace daily basal metabolic loss in addition to loss from exercise and other physical activities.

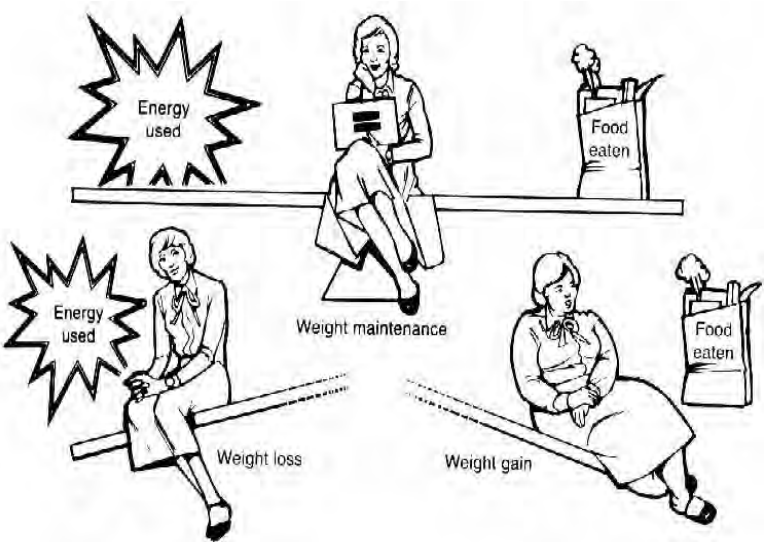


Fig 20.1 Energy Balance

Source : Susan. R. Holman, 1987. Essential of Nutrition for the Health Professionals.

Obesity represents an energy imbalance resulting from an excess of energy input over energy output (expenditure). Extreme weight loss is a state of energy imbalance resulting from a deficit energy input over energy output.

Questions

Part A

Fill in the blanks:

1. The unit of energy is _____.
2. The energy value of foods is measured using a _____.
3. 1 gm of carbohydrate yields _____ kcal.
4. 1 gm of fat yields ___ kcal.
5. Protein is not digested completely due to_____
6. Fever _____BMR.
7. A teacher is classified as doing _____activity.

8. The rate of energy expenditure in terms of BMR units for moderate activity is _____.

Part B

Write short answers:

1. Define Kcal.
2. What is Basal Metabolic rate?
3. What is dietary thermogenesis?
4. Define BMR unit.
5. Give the physiological fuel value of carbohydrate, protein & fat.

Part C

Write detailed answers:

1. Discuss the factors influencing basal metabolic rate.
2. How are daily energy requirements arrived at?

21. MINERALS AND VITAMINS

Until the middle of the nineteenth century, the importance of minerals and vitamins was not known. It was observed that carbohydrate, fat, protein alone were incapable of promoting and sustaining growth.

Hence scientists attempted to find out the "missing elements", namely minerals and vitamins which are essential for growth and maintenance.

Essential minerals which are inorganic substances are classified as macro and micronutrients based on the amount needed by humans per day.

Macrominerals are those which are vital to health and that are required in the diet by more than 100mg per day and those required in the diet less than 20mg per day are called microminerals or trace minerals.

The essential microminerals are Calcium, Phosphorous, Magnesium, Sulphur, Potassium and Chloride. Important microminerals of relevance in human nutrition are Iron, Zinc, Copper, Sodium, Cobalt, Fluoride, Manganese, Chromium, Iodine and Molybdenum.

21.1 FUNCTIONS, FOODSOURCES, REQUIREMENTS AND EFFECTS OF DEFICIENCY.

Calcium and Phosphorus:

Calcium is an essential element required for several life processes. The requirements of Calcium and Phosphorous are considered together as their function and requirement are closely linked.

Over 99% of the Calcium and Phosphorous is present in the bones and the remaining 1% in the body fluids.

The Calcium and Phosphorous are present in the ratio of 2:1 in our body. In the skeletal system Ca and P is present in the form of hydroxyapatite crystals.

Hydroxyapatite is a compound made up of calcium and phosphate that is deposited into the bone matrix to give it strength and rigidity.

Functions :

1. Bone formation:
   The major mineral ions of the bone are Calcium, Phosphorous and Magnesium. For proper calcification of bones, (deposition of minerals on the bone matrix) which occurs during the growing years, adequate supply of these minerals is essential.
2. Tooth formation: - Calcium and Phosphorous together as a compound is essential for the formation of dentin and enamel.
3. Physiological Process: -
   a. Calcium is essential for the clotting of blood as it is required for prothrombin activation.
   b. Calcium regulates the permeability of the capillary walls and ion transport across the cell membranes.
   c. It is essential for the contraction of the heart and skeletal muscle.
   d. Ca regulates the excitability of the nerve fibres.
   e. Ca acts as an activator for enzymes such as rennin and pancreatic lipase.
4. Phosphorous is essential for the storage and release of adenosine triphosphate (ATP) molecules.
5. Phosphates plays an important role as buffers to prevent changes in acidity of the body fluids.
6. Phoshpolipids are major components of cell membrane and intra cellular organelles.
7. In the DNA and RNA phosphate is an essential part of the nucleic acids.

Food sources

Among cereals ragi contains large amounts of calcium. Bengalgram whole, gingely seeds, cuminseeds, poppy seeds, agathi, amaranth, drumstick leaves are good sources of calcium. Milk and milk products are good sources of calcium and phosphorous. Only 20 – 30 % of the calcium in the diet is absorbed, which is facilitated by Vitamin – D. All foods contain significant amounts of phosphorous.

Requirements

The recommended dietary allowances for Calcium, as suggested by the ICMR is given in table-21A.

Table 21 A

ICMR recommended dietary allowances for Calcium

	Age Group	RDA for calcium mg/day
Infant	0 – 12 months	500
Children	1 – 9 years	400
Children	10 – 15 years	600
Adolesent	16 – 18 years	500
Adult		400
Pregnant women		1000
Lactating women		1000

Deficiency

Calcium related health problems occur due to inadequate intake, improper absorption or utilization of calcium.

Osteoporosis:

Osteoporosis is a condition found primarily among middle aged and elderly woman, where the bone mass of the skeleton is diminished.

It is a condition of multiple origin. It results due to the following reasons:

(i) Prolonged dietary inadequacy

(ii) Poor absorption and utilization of calcium

(iii) Immobility
(iv) Decreased levels of oestrogen in post menopausal women.
(v) Hyper parathyroidism
(vi) Vitamin – D deficiency

Osteomalacia – is a condition in which the quality but not the quantity of bone is reduced. This condition is dicussed in detail under deficiency of Vitamin – D.

Tetany

Tetany occurs when Calcium in the blood drops below the critical level. There is a change in the stimulation of nerve cells resulting in increased excitability of the nerve and uncontrolled contraction of the muscle tissue. Hence Calcium and Phosphorous ratio in the diet should be maintained at 1:1 for proper utilization of Calcium in the body.

Microminerals

Microminerals are also known as trace elements. The microminerals are Iron, Iodine, Zinc, Copper, Fluoride, Selenium, Chromium, Manganese, cobalt and Molybdenum. However only the deficiency of few of these elements is observed in humans. Iron and Iodine deficiencies are wide spread while deficiency of Cu, Zn, Cr and Se have been reported in recent years.

Iron

The total body iron is 4g in adults. Iron exists in a complex form in our body. It is present as

a) Iron porphyrin compounds – hemoglobin in RBC, myoglobin in muscle.
b) Enzymes – (eg) peroxidases, succinase dehydrogenase and cytochrome oxidase.

c) Transport and storage forms: - (eg) transferrin and ferritin.

Functions :

The chief functions of iron in the body are :

1. Iron forms a part of the protein – haemoglobin which carries oxygen to different parts of the body.
2. It forms a part of the myoglobin in muscles which makes oxygen available for muscle contraction.
3. Iron is necessary for the utilization of energy as part of the cells metabolic machinery.
4. As part of enzymes iron catalizes many important reactions in the body. Examples are
   a) Conversion of beta carotene to active form of Vitamin A
   b) Synthesis of carnitine, purines, collagen and neuro transmiters.
   c) Detoxification of drugs in the liver.

Food Sources

The iron present in food can be as haem and non-haem iron depending upon the source from which it is obtained. Haem iron – is obtained from animal tissues, non-heam iron – is obtained from plant foods.

Sources of non-haem iron are ragi, green leafy vegetables, dried fruits and jaggery. Liver, fish, poultry, meat, eggs dates are good sources of haem iron .

Haem iron is absorbed and utilized better than the non-haem iron. Iron absorption from Indian diets is only 3 percent as it is mainly cereal based diet.

Requirement

Iron requirements for various age groups is listed in table-21B.

Table 21 B
ICMR – Recommended dietary Allowances for Iron

Group	Iron requirement (mg/day)
Birth – 1 year	1
1 – 5 year	15 – 20
6 – 12 years	15 – 20
13 – 18 years Boys Girls	 25 35
Man	20
Woman	30
Pregnancy	40
Lactation	30

Deficiency

Dietary iron deficiency leads to nutritional anaemia. Nutritional anaemia is defined as the condition that results from the inability of the erythropoetic tissue to maintain a normal haemoglobin concentration.

Anaemia occurs when the haemoglobin level falls below 12 gm /dl in adult man and woman. During pregnancy haemoglobin level below 11 gm /dl is termed anaemia.

Nutritional anaemia is the common form of anaemia affecting women in reproductive years, infants and children which is mainly due to poor intake and absorption.

Iron deficiency anaemia is wide spread in our country. The prevalence varying from 45% in men and 70% in women and children. The major cause of anemia in India is because of Iron and folic acid deficiency.

Nutritional anemia is manifested as :

1. Reduced Haemoglobin level. (less than 12 g /dl)
2. Defects in the structure, function of the epithelial tissues
3. Paleness of skin and the inside of the lower eyelid is pale pink

4. Finger nails becoming thin and flat and eventually (spoon shaped nails) koilonychia develops.
5. Progressive untreated anaemia results in cardiovascular and respiratory changes leading to cardiac failure. The general symptoms include lassitude, fatigue, breathlessness on exertion, palpitations, dizziness, sleeplessness, dimmness of vision, and increased susceptibility to infection.

Iodine

Iodine is an essential constituent of the thyroid hormone produced by the thyroid glands. It occurs as free iodide ions or as protein bound iodine in our body. About 15 – 23 mg of iodine is present in the adult human body.

The body store of iodine is predominantly present in thyroid gland and also in salivary gland, mammary glands gastric glands and in kidneys to a certain extent.

Function

Iodine is essential for the synthesis of the thyroid hormones T_3 and T_4.

Sources

Richest source of iodine are sea foods like sea fishes and common salt from sea water. Iodine content of vegetables, fruits and cereals depends upon the iodine content of the soil in which they grow. The soil of mountaineous regions contains less iodine.

Requirement

The ICMR recommended dietary allowance for Iodine is 150 µg/day.

Deficiency

Iodine deficiency in the diet, causes enlargement of the thyroid gland called as “goitre”. Goitre occurs in people staying

in hilly regions where the iodine content of water and soil is comparatively less.

In India goitre is common in hilly districts of Himalaya. Goitre can be treated by administration of iodine. If treatment is given in early stages goitre can be corrected.

Severe iodine deficiency in children leads to hypothyroidism resulting in retarded physical and mental growth. This condition is known as cretinism.

Goitrogens are substances present in foods which cause goitre. These substances react with iodine present in the food making it unavailable for absorption. Foods like cabbage, cauliflower, raddish contain goitrogens.

Zinc

Zinc is primarily intracellular substance. Its total quantity in the body is 2.3g. Largest stores of Zinc is present in the bones. Zinc forms a constituent of the blood. Zinc is an important element performing a range of function in the body as it is a cofactor for a number of enzymes.

Functions

1. Zinc is a constituent of enzymes such as carbonic anhydrase, alkaline phosphatase, lactic dehydrogenase.
2. It is a constitutent of the hormone insulin
3. It plays a major role in the synthesis of DNA and proteins.

Sources

Meat, unmilled cereals and legumes are good sources. Fruits and vegetables are poor sources.

Requirements

The daily requirement of Zinc in adults is 15.5 mg / day as recommended by the ICMR expert group.

Apart from iron, iodine, zinc, copper, selenium and fluorine are essential trace elements. Copper is essential element in iron absorption.

Selenium is an essential element along with Vitamin E for maintaining integrity of the liver cells. Fluorine is required in

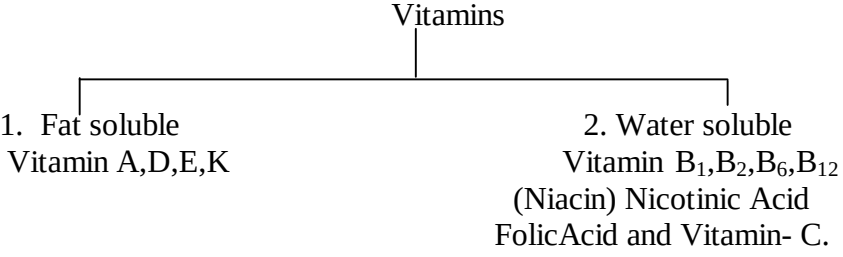
minimum amounts to prevent dental caries. Excessive consumption leads to mottling of teeth.

Vitamins

Vitamins are organic substances present in small amounts in food, they are required for carrying out vital functions of the body. They are involved in the utilization of the major nutrients like proteins, fats and carbohydrates.

Though needed in small amounts, they are essential for health and well being of the body. When these Vitamins were discovered on the basis of their function and before their chemical nature were elucidated, they were designated as A,B,C,D or in terms of their major functions like, antineuritic, antirichitic Vitamins. Vitamins are classified based on their solubility as fat soluble and water soluble vitamins.

21.2 CLASSIFICATION OF VITAMINS



Water soluble vitamins are not accumulated in the body , but are readily excreted while fat soluble vitamins are stored in the body. For this reason excessive intake of fat soluble vitamins, especially Vitamin A and D can prove toxic. Excessive intake leads to the condition called hypervitaminosis.

21.2.1 Functions, food sources, requirements and effects of deficiency

Fat soluble vitamins:

Vitamin A

Vitamin A was the first fat soluble vitamin to be recognized. Three forms of Vitamin A are active in the body,

retinol, retinal and retinoic acid. They are collectively called as retinoids .

Beta carotene is the provitamin of Vitamin A. Provitamins are substances that are chemically related to a vitamin but must be changed by the body into the active form of the vitamin. Vitamin A in the diet comes in two forms.

Retenoids (preformed Vitamin A) and carotenoids. Vitamin A is present in vegetable foods which contain yellow pigment called carotenes. It was isolated from carrots hence called carotenoids which are provitamins of Vitamin A.

Functions.

1) A well understood function of retinol is in the visual process. The retina of the human eye contains two distinct photo receptors of which one is sensitive to light intensities . Vitamin A is essential for the formation of rhodopsin and normal functioning of the retina for clear vision in dim light. Lack of Vitamin A leads to impaired adaptation to darkness.
2) Participates in protein synthesis and cell differentiation and thereby maintaining the health of the epithelial tissues and skin.
3) Supports reproduction and growth
4) Vitamin A regulates the antibodies and cellular immune response. It is essential for maintaining the epithelial tissue which is the first line of defence against invading microorganism.
5) Beta carotene acts as an antioxidant capable of protecting the body against disease like cancer, cardiovascular diseases and cataract.

Sources

Vitamin A in the human diet exist as retinol or as retinal or beta carotene which has to be converted to Vitamin A. Foods of animal origin contain retinol.

Plant sources are rich in Beta carotene. Only one third of the dietary beta Carotene is absorbed.

Beta Carotene from green leafy vegetables is well utilized than from carrots and papayas.

Good sources of Vitamin A are sheep liver, butter, ghee, egg, milk, curds, liver oils of shark and halibut.

Good sources of beta carotene are agathi, amaranth, drumstick leaves, green leafy vegetables, mango, papaya, carrot and jack fruit.

Requirements:

The ICMR recommended dietary allowance for retinol is given in table-21C.

Table 21 C

ICMR recommended dietary allowance for Retinol

Group	**Retinol µg/day**
Man	600
Woman	600
Pregnant women	600
Lactation	950
Infants	350
Children	400-600

Effects of Deficiency

Deficiency of Vitamin A is manifested as nutritional blindness and increased susceptibility to infection. Nutritional blindness is an important public health problem among young children in India .

Night blindness is an early symptom of Vitamin A deficiency. The individual cannot see in dim light. This can be corrected with adequate supply of Vitamin A. In the absence of adequate Vitamin A intake the outer lining of the eye ball loses its usual moist, white appearance and becomes dry and wrinkled called xerosis.

This condition is followed by raised muddy dry triangular patches on the conjunctiva called the bitots spots. Redness and inflammation of the eye and gradual loss of vision may follow. The central portion of the eye loses its transparency and becomes opaque and soft if not treated and leads to total blindness termed Xeropthalmia. Xeropthalmia encompasses all ocular manifestations of Vitamin A deficiency.

Increased susceptibility to infection occurs because the mucous membrane lining becomes dry and rough which is easily invaded by the micro – organism.

Hypervitaminosis

Intake of large amount of Vitamin A for prolonged periods can lead to toxic symptoms which include irritability, headache, nausea and vomitting.

Vitamin D

Vitamin D can be synthesized in the body in adequate amounts by simple exposure to sunlight, even for 5 minutes per day is sufficient.

It is essential for bone growth and calcium metabolism. It acts as a hormone in the body by facilitating calcium absorption and deposition in the bone.

Functions

1. Vitamin D helps in the absorption of calcium and phosphorous by increasing the synthesis of calcium binding protein.
2. Vitamin D helps to maintain the calcium and phosphorous levels in the body by stimulating,
    a) Absorption in the gastro intestinal tract.
    b) Retention by the kidney
3. Vitamin D helps in deposition of calcium in the bones.
    The bones grow denser and stronger.

Food Sources

The Vitamin D content of food sources from animals varies with the diet, breed and exposure to sunlight of the animal.

The good sources of Vitamin D are cod liver oil, shrimp, liver, butter, yolk, cheese, milk, spinach and cabbage.

Requirements

The expert group of ICMR has not recommended dietary intake of Vitamin D for Indians.

Only in those cases where the Vitamin D requirement is not met due to inadequate exposure to sunlight the ICMR recommends 400 µg/day of Vitamin D .

Deficiency

Deficiency of Vitamin D leads to decreased absorption of calcium which is manifested as muscular tetany, rickets in children and osteomalacia in adults.

Due to faulty calcification of bones the following derfomities is manifested in children which is called rickets. It is a disease in which there is weakness and abnormalities in bone formation. Rickets primarily affects children.

Fig 21.2 Vitamin D deficient child-Rickets

Source : Venkatachalam.P.S and Rebello.R.M. 1996 Nutrition for Mother and Child. NIN; ICMR.

Manifestations:

a) faulty deposition of calcium on the bones.
b) Bowing of legs
c) Enlargement of ends of long bones
d) Deformities of ribs – beading of ribs
e) Delayed closing of frontanel
f) Slow erruption of teeth.
g) Malformed, decay – prone teeth

Osteomalacia in Adults

Osteomalacia is a condition where the quality of the bone is reduced. It occurs in women who are not exposed to sunshine and who have depleted mineral reserves resulting from successive pregnancies and prolonged lactation.

Osteomalacia is associated with low phosphorous level but low blood calcium level is the most frequent cause.

The following symptoms occur

1. softening of the bones
2. deformities of the limbs, spine, thorax and pelvis
3. demineralization of the bones
4. pain in pelvis, lower back and legs
5. frequent bone fractures.

Hypervitaminosis

As in the case of Vitamin A intake of excessive amounts of Vitamin D leads to toxic symptoms which include irritability, nausea , vomiting and constipation.

Vitamin E

Vitamin E is known as antisterility vitamin because it is required for normal reproduction in animals and men.

Functions

1. Vitamin E is the primary antioxidant in the body and serves to protect polyunsaturated fatty acids (PUFA) from oxidation in cells and maintain integrity of the cell membrane. It also prevents the oxidation of beta carotene and Vitamin A. Vitamin E helps to maintain cell membrane integrity and protect RBC against hemolysis.

2. Vitamin E reduces platelet aggregation
3. Vitamin E is essential for the iron metabolism and the maintenance of nervous tissues and immune function.
4. Vitamin E is been promoted as an anti-aging vitamin, because as cells age they accumulate lipid breakdown products. Vitamin E prevents this accumulation in maintaining cell health.

Food Sources

Vitamin E is widely distributed in foods. It is present in high concentration in vegetable oils and in cereal grains. Wheat gum, sunflower seeds, almonds, safflower oil, eggs, butter are good sources.

Meat, fruits and vegetables contain small amounts. Sesame oil and mustard oil are good sources of Vitamin E.

Requirement :

The requirement of Vitamin E is linked to that of essential fatty acids (linoleic and linolenic acids). The requirement of Vitamin E is 0.8 mg/g of essential fatty acid.

Deficiency

1. Prolonged intake of Vitamin E deficient diets produces uncoordinated movement, weakness and sensory disturbances.
2. It causes haemolytic anaemia in low birth weight infants
3. Defective functioning of the retina leading to permanent blindness in premature infants occurs.
4. It leads to reproductive failure in humans
5. Vitamin E deficiency is associated with decreased ability of the lymphocytes.

Vitamin K :

Vitamin K is recognized as the anti haemorrhagic factor owing to its vital role in blood clotting mechanism.

Functions

Synthesis of blood clotting proteins. Vitamin K is essential for the activation of prothrombin. This gets converted

to thrombin, which in turn activates fibrinogen to form fibrin. The process of blood clotting occurs as follows:

Injured tissue releases thromboplastin, which catalyses prothrombin formation. Vitamin K catalyses, conversion of prothrombin to thrombin. This in turn causes conversion of fibrinogen to fibrin which forms the clot.

Food Sources:

Dark green leafy vegetables are good sources of vitamin K. Fruits, tubers, seeds, dairy and meat products contain Vitamin K.

Requirements :

The ICMR committee considered that no recommendation is needed for this Vitamin, as the synthesis of Vitamin K occurs in the lower intestine by the colonic bacteria and present widely in foods.

Effects of Deficiency:

Primary deficiency arises in infants resulting in delayed blood clotting and hemorrhage. This is because the new born babies have a sterile intestinal tract thus lack in the colonic bacterial colonies which produces Vitamin K. Vitamin K deficiency does not occur in adults.

Water soluble Vitamins:

Vitamin C (Ascorbic Acid)

The chemical name for Vitamin C is ascorbic acid. It was discovered in 1747 by the British physician Lind and demonstrated that citrus fruit juices prevented and cured scurvy.

Functions :

1. Ascorbic Acid is essential for formation of cement substances and collagen which is found in blood vessels teeth and bones.
2. It helps in the biosynthesis of non-essential amino acids (eg) hydroxy proline, tyrosin.
3. It is required for absorption of iron as it reduces ferric to ferrous form which is easily absorbed.

4. Vitamin C is essential for the formation of collagen a major structural protein of connective tissues.
5. It is required for normal wound healing because it helps in the formation of connective tissue.
6. Vitamin C is required for carnitine synthesis which aids in the transport of fatty acids in the cell.
7. Vitamin C is essential for the synthesis of norepinephrine a neurotransmitter.
8. It activates hormones (eg) growth hormone, gastrin releasing peptide, calcitonin, gastrin oxytocin.
9. Drug detoxifying metabolic systems in the body require Vitamin C for its optimal activity.
10. Vitamin C is an excellent anti-oxidant. It combines with free radicals oxidizing them to harmless substances that can be excreted.

Food Sources:

Amla, drumstick leaves, guava, cashew fruit, agathi, cabbage, bitter gourd, oranges, tomatoes are good sources of ascorbic acid. Cereals and pulses are poor sources. Vitamin C content of pulses increases on germination.

Requirements:

The recommended dietary allowances of ICMR for ascorbic acid is as given in table-21D.

Table 21 D
ICMR Recommended Dietary Allowances for Vitamin C

Group	Requirement mg/day
Adult	40
Pregnant women	40
Lactation	80
Infants	25
Children	40

Effects of Deficiency:

Prolonged deficiency of ascorbic acid produces a disease condition called as ‘ scurvy’ in both infants and adults.

Infantile scurvy:

There is loss of appetite, failure to gain weight, irritability, palor, defective growth of bones. Haemorrhage occurs under the skin. There is defective formation of teeth and gums are swollen. The ends of the ribs become prominent resulting in beaded appearance called scorbutic rosary.

Adult Scurvy:

1. General manifestation are fever, susceptibility to infection, and delayed wound healing.
2. Anaemia: Microcytic hypochromic anaemia develops due to failure of absorption of iron.
3. Gums become spongy and bleed easily. Gums become swollen and ulcerated.
4. The blood vessels become fragile and porous due to defective formation of collagen. Joints become swollen and tender.
5. Clinical symptoms appear when total body pool of ascorbic acid decreases. Skin becomes rough and dry. There are small petechial hemorrhages around hair follicles.

Thiamine

Thiamine is known as Vitamin B_1. Deficiency of thiamine leads to beri – beri. This condition is widely prevalent among population whose diet contains more of polished cereals.

Functions

1. Thiamine is converted to thiamine pyrophosphate (TPP), which is an important co enzyme in the carbohydrate metabolism.
2. It is involved in transmission of nerve impulses across the cells
3. Thiamine as TPP is an essential cofactor for the conversion of amino acid tryptophan to niacin.

Sources:

Yeast, whole wheat, millets, hand pounded rice, parboiled rice are good sources of thiamine. The bran contains most of the thiamine in the cereals. Gingelly seeds, groundnut, soyabean, cashewnuts, organ meats, pork, liver and eggs supply thiamine.

Requirements

Thiamine is involved in the carbohydrate metabolism. Its requirement is related to energy derived from carbohydrate. The ICMR expert group recommends an allowance of 0.5 mg per 1000 Kcal for adults and for infants 0.3 mg/1000 Kcal is suggested. The recommended dietary allowance per day is given in table-21E.

Table 21 E

ICMR Recommended Dietary Allowance For Thiamine Per Day

Group	Thiamine requirement mg/day
Man	
Sedentary	1.2
Moderate	1.4
Heavy work	1.6
Woman	
Sedentary	0.9
Moderate	1.1
Heavy work	1.2
Pregnant woman	+0.3
Lactation	+0.3 - +0.2
Infants	55 mg/kg – 50 mg/kg
Children (1 – 9 years)	0.6 – 1.2
Boys (10 – 18 years)	1.1 – 1.3
Girls (10 – 18 years)	1.0

Effects of Deficiency

Deficiency of thiamine is associated with low calorie intake. Severe deficiency of thiamine produces a disease known as beri – beri.

It is manifested as

a. Dry beri – beri
b. Wet beri – beri
c. Infantile beri – beri

a. Dry beri – beri

There is loss of appetite, tingling numbness and burning sensation in hands and feet. Calf muscles are tender. Knee and ankle jerks are sluggish.

In later stages complete loss of sensation in hands and legs occur. It is characterized by foot and waist drop. Mental depression and confusion occurs.

b. Wet beri – beri

In this case there is enlargement of heart and the cardiac output is high. Oedema or accumulation of fluid in legs, face and trunk is observed. palpitations are marked.

c. Infantile beri – beri

It occurs in first few months of life if the diet of the mother is deficient in thiamine. Symptoms are restlessness, sleeplessness, constipation, enlargement of the heart and breathlessness.

Riboflavin

Riboflavin or Vitamin B2 is the yellow enzyme which is heat stable unlike other B Vitamins. Riboflavin in the combined form with proteins form flavo proteins or yellow enzymes.

This enzyme is of two types FAD – Flavin-di-nucleotide. FMN- Flavin mono-nucleotide.

a. These substances act as coenzymes in many biological reactions primarily in oxidation – reduction, and dehydrogenation reaction
   i) Release of energy from glucose, fatty acids and amino acids.
   ii) Conversion of vitamin B_6 and folate to active coenzymes.

c) It is essential for the formation of red blood cells

d) It is required for the synthesis of glycogen

Food Sources:

Rich sources are liver, dried yeast, egg, milk , meat, fish, whole cereals, legumes, and green leafy vegetables.

Requirements

Riboflavin requirement is related to energy intake – 0.6 mg/1000Kcal. The ICMR recommends the following requirement per day as given in table-21F.

Table 21 F

ICMR Recommended Dietary Allowance for Riboflavin

Group	Riboflavin mg/day
Man	
Sedentary	1.4
Moderate	1.6
Heavy work	1.9
Woman	
Sedentary	1.1
Moderate	1.3
Heavy work	1.5
Pregnant woman	+0.2
Lactation	+0.3
Infants	65 mg/kg – 60 mg/kg
Children (1 – 9 years)	0.7 – 1.2
Boys (10 – 18 years)	1.3 – 1.6
Girls (10 – 18 years)	1.2

Effects of Deficiency

Riboflavin deficiency is prevalent mainly among the low income groups particularly the vulnerable group and the elderly adults. Riboflavin deficiency is characterized by

1. Soreness and burning of the mouth and tongue.

2. Lesions at the angles of the mouth called Angular Stomatitis.
3. The inflammation of the tongue called glossitis

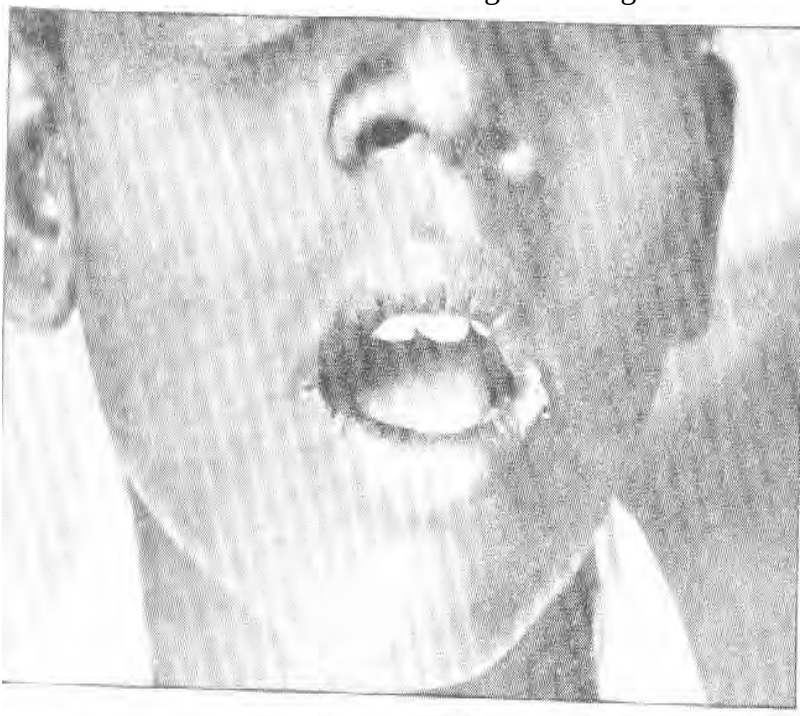


Fig 21.3 Angular Stomatitis (Soreness and ulceration on lips at the corners of the mouth)

Source : Venkatachalam.P.S and Rebello.R.M. 1996 Nutrition for Mother and Child. NIN; ICMR.

4. Dry chapped appearance of the lip with ulcers termed cheilosis.
5. The skin becomes dry and results in seborehoeic dermatitis.
6. Photophobia, lacrimation, burning sensation of the eyes and visual fatigue.
7. Decreased motor co-ordination
8. Normocytic anaemia

Niacin

Niacin or Nicotinamide (amide form) is required by all the cells of our body.

Like thiamine and riboflavin it plays a vital role in the release of energy from carbohydrates , protein, fat and alcohol.

Functions

1) Nicotinamide is essential for tissue metabolism. The active forms of nicotinanide are NAD – Nicotinamide adenine dinucleotide and NADP - Nicotinamide adenine dinucleotide phosphate.
2) NAD and NADP are involved as coenzymes in large number of reversible oxidation reduction reactions.
3) Nicotinic acid enhances stomach secretion
4) NAD is involved in catabolic reactions and NADP is involved in anabolic reaction in our body.

Food Sources

Dried yeast, liver, rice polishing, peanut, whole cereals, legumes, meat, fish, are good sources.

Tryptophan present in dietary protein is converted to niacin in humans. 60 mg of tryptophan yields 1 mg of niacin.

Requirements :

ICMR recommended dietary allowance of Niacin per day is given in table 21G.

Table 21 G

ICMR Recommended Dietary Allowance for Niacin

Group	Niacin requirement mg/day
Man	16 – 21
Woman	12 – 16
Pregnant woman	+2
Lactation	+4
Infants	710 mg/kg – 650 mg/kg
Children (1 – 9 years)	8 – 13
Boys (10 – 18 years)	15 – 17
Girls (10 – 18 years)	13 – 14

Effects of Deficiency

Deficiency of nicotinic acid causes a disease known as pellagra. It is characterized by three D's à Dermatitis, Diarrhoea and Dementia.

1. **Dermatitis** – Name pellagra comes from pelle-skin and agra-rough. Marked changes occur in the skin especially in the skin exposed to sun and friction areas like elbows, surfaces of arms, knees.

   Lesions are symmetrically distributed, in the affected parts. At first there is reddening, thickening and pigmentation of the skin.

   Later on there is exfoliation leading to ultimately parchment of skin – butterfly like appearance.
2. **Diarrhoea** – Diarrhoea enhances the deficiency state. There are structural and absorptive defects in the small intestine. Tongue appears raw, and mucous membrane of the tongue is inflammed.
3. **Dementia** – There is irritability, depression, poor concentration and loss of memory. Delirium is a common mental disturbance.

Folic Acid

Folic acid was first extracted from dark green leafy vegetables. It forms yellow crystals and is a conjugated substance made up of three acids namely pteroic, para amino benzoic acid and glutamic acid.

Functions

1. Folic acid coenzyme is essential in bringing about transferring single carbon units for many interconversions. A number of key compounds are formed by these reactions like (i) Purines which are essential constituents of living cells.

   (ii) Thymine – this essential compound forms a key part of DNA.

   (iii) the formation of haem group of haemoglobin.
2. The conversion of phenylalanine into tyrosin.

Food Sources:

Green leafy vegetables, liver, kidney, gingelly seeds, cluster beans, are rich sources of folic acid.

Requirements

The recommended dietary allowances of Folic acid by ICMR are given in table-21H .

Table 21 H

ICMR Recommended Dietary Allowance for Folic acid

Group	Folic acid mg/day
Man	100
Woman	100
Pregnant woman	400
Lactation	150
Infants	25
Children (1 – 9 years)	30 – 60
Boys and girls (10 – 18 years)	70 – 100

Deficiency

1. Simple folate deficiency results in the bone marrow producing immature cells (megaloblasts cells) and few matured red blood cells. This results in reduced oxygen – carrying capacity causing anaemia termed - Megaloblastic anaemia.
2. Folate deficiency during pregnancy causes neural tube disorders of the foetus.
3. Folate deficiency impairs the ability of the immune system to fight infection.

Pyridoxine (B_6)

Pyridoxine is unique among B – complex Vitamins in that it functions primarily in protein metabolism.

Pyridoxine denotes related substances such as Pyridoxine, Pyridoxal and Pyridoxamine are three forms in which it is present in our body.

Functions

Vitamin B_6 in the form of pyridoxal phosphate functions as a co-enzyme in many biological reactions

1. Pyridoxine is essential for the process of
    a. Transamination : transfer of amino group from one aminoacid to another.
    b. Deamination : Removal of the amino group
    c. Decarboxylation: Removal of the carboxyl group
2. Vitamin B_6 is involved in several biochemical steps for the conversion of the amino acid tryptophan to niacin
3. It aids in the formation of elastin, synthesis of messenager RNA and haem part of haemoglobin.
4. It aids in the conversion of linoleic acid to arachidonic acid.
5. In the carbohydrate metabolism it aids in the release of glycogen from liver and muscle.

Food sources:

Meat, pulses and wheat are rich sources. Other Cereals are fair sources of this vitamin. Fruits and vegetables are poor sources. Cooking and processing of food causes loss of this vitamin.

Requirement: The ICMR recommended dietary allowance for pyridoxine is given in table-21 I.

Table 21 I

The ICMR Recommended Dietary Allowance for Pyridoxine

Group	Pyridoxine mg/day
Adults	2.0
Pregnant woman	2.5
Lactation	2.5
Infants	0.1 – 0.4
Children (1 – 9 years)	0.9 – 1.6
Boys and girls (10 – 18 years)	1.6 – 2.0

Deficiency

Vitamin B_6 deficiency leads to abnormalities in protein metabolism which is manifested as poor growth, convulsions,

anaemia, decreased antibody formation and skin lesions. Severe deficiency leads to microcytic hypochromic anaemia.

Symptoms such as weakness, nervousness, irritability, insomnia and difficulty in walking is predominant.

Vitamin B_{12} (Cyanocobalamin)

Until 1926, pernicious anaemia was a fatal disease of unknown origin with an unknown cure. In 1926 Minot and Murphy found that pernicious anaemia could be cured by feeding a patient atleast 0.3 kg of raw liver per day.

Also in 1926 Castle noted that patients with pernicious anaemia had a low level of gastric secretion. He suggested that the anti-pernicious anaemia factor had two components.; an ' extrinsic factor' found in food and an ' intrinsic factor' within normal gastric secretions. The extrinsic factor is now known as vitamin B_{12} – cobalamine.

Functions :

Vitamin B_{12} is necessary for normal growth and maintenance of healthy nervous tissue and normal blood formation.

Vitamin B_{12} is involved in DNA synthesis and thus in cell replication.

In the bone marrow the Vitamin B_{12} co-enzymes are essential for the formation of red blood cells.

It facilitates the formation of folate co-enzymes needed for nucleic acid synthesis.

Vitamin B_{12} is also required for the synthesis of myelin sheath that surrounds the nerve fiber.

Food sources

Vitamin B_{12} is present only in foods of animal origin. Liver sheep, shrimp, mutton , egg, milk are good sources of Vitamin B_{12}.Vitamin B_{12} is synthesized by the colonic bacteria.

Requirements :

The recommended dietary allowance prescribed by ICMR for B_{12} are given in table 21J.

Table 21J
The ICMR Recommended Dietary Allowance for VitaminB$_{12}$

Group	Vitamin B_{12} mg/per day
Man	1.0
Woman	1.0
Pregnancy	1.0
Lactation	1.5
Infants	0.2
Children boys and girls	0.2 – 1.0

Deficiency

Pernicious amaemia is the major problem arising from an inadequate amount of vitamin B12.

Pernicious amaemia is a condition characterized by very large, immature red blood cells with normal amounts of haemoglobin.

QUESTIONS

Part B

Write short answers:

1. What are macro minerals and micro minerals give example?
2. What is a provitamins?
3. What is hypervitaminosis?
4. List the functions of calcium and phosphoros?
5. What are goitrogens?
6. Discuss the functions of Iron?

7. Discuss the role of Vitamin A in the visual process?
8. Why is Vitamin E called the anti-sterility vitamin?
9. Explain the process of clotting of blood?
10. List any two differents between fat soluble and water soluble vitamins?

Part C

Write detailed answers:

1. Discuss Vitamin A,D,E,K under the following heads
    a. Functions
    b. Requirements
    c. Sources
    d. Effects of deficiency
2. Discuss effects of deficiency of the B-complex vitamins?
3. Explain in detail the functions and deficiency of Vitamin C?

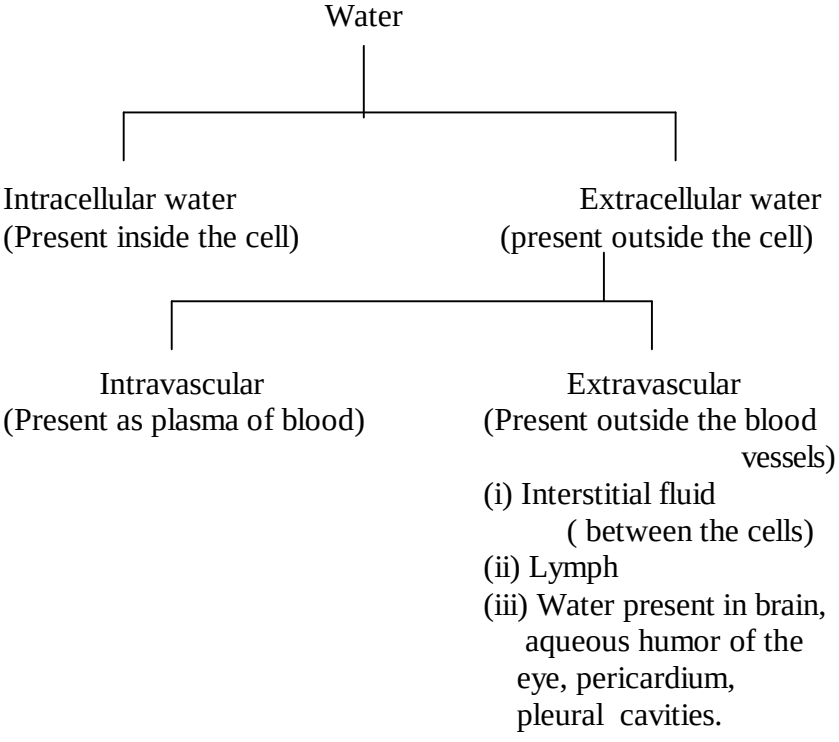
22. WATER

Water is vital for human existence. We can live with out food for extended periods of time, but without water will result in death.

Water is colourless, calorie less compound of hydrogen and oxygen that virtually every cell in the body needs to survive. Water is closer being a universal solvent than any other compound.

Water is the largest single compound of the body and it is distributed as follows.

Distribution of water in the body



Total body water content is mainly determined by total amount of salt in the body. Salt and water concentration in the body is controlled by the kidneys.

22.1 FUNCTIONS OF WATER

1. It is an essential constituent of all the cells of the body and the internal environment.
2. Serves as a transport medium by which most of the nutrients pass into the cells and removes excretory products.
3. Water is a medium for most biochemical reactions within the body and sometimes a reactant.
4. It is a valuable solvent in which various substances such as electrolytes, non – electrolytes, hormones, enzymes, vitamins are carried from one place to another.
5. Plays a vital role in the maintenance of body temperature. Heat is produced when food is burnt for energy. Body temperature must be kept at 80º - 108º Fahrenheit for higher or lower body temperature will cause death. Body heat is lost through the skin, lungs, urine and faeces.
6. It forms a part of fluids in body tissues; (eg) the amniotic fluid surrounds and protects the foetus during pregnancy.
7. Saliva is about 99.5 percent water. In healthy individuals it makes swallowing easier by moistening the food.
8. Water helps in maintaining the form and texture of the tissues.
9. Water is essential for the maintenance of acid base and electrolyte balance. It should be noted that pure water consists of hydrogen ion (H+) and hydroxyl ion (OH^-).

Substances dissolve in water as ions with positive and negative charge. They are called electrolytes. The common electrolytes in our body are sodium, potassium and chloride.

Changes in electrolyte balance causes accumulation or depletion of water in intracellular and extra cellular fluid.

The balance between the positively and negatively charged ions is essential for water flow and maintain osmolarity between the cells. This is called electrolyte balance.

Acid base balance is the dynamic state of equilibrium of hydrogen ion concentration. When pH falls below 7 it is termed acidity and when it increases above 7 it is termed alkalinity.

Extremes of both cases results in death. The pH of the body should be maintained near neutrality. Enzymatic action depends on the pH. The digestion, absorption and utilization of nutrients are dependent on pH. Most body fluids are near neutral with the exception of gastric juice.

The pH value of some solutions are given below:

Acid

0 – Hydrochloric acid

1

2 – Gastric juice

3 – Vinegar, orange juice

4 – Grapes

5 – Bread, coffee

Neutral 6 – Urine

7 – Pure water, eggs, blood

8 – Sea water

14 – Sodium hydroxide

Alkali

10. Water forms good source of macro minerals like Calcium, Magnesium, Fluoride, Iron and Iodine.

22.2 REQUIREMENTS

Requirements of water varies with climate, dietary constituents, activities and surface area of the body. As a rule a person should take enough water to excrete about 1200 –1500 ml of urine per day. In tropics because of greater water loss through perspiration increased water intake is required to maintain urine volume. Normal intake of water ranges between 8 – 10 glasses per day.

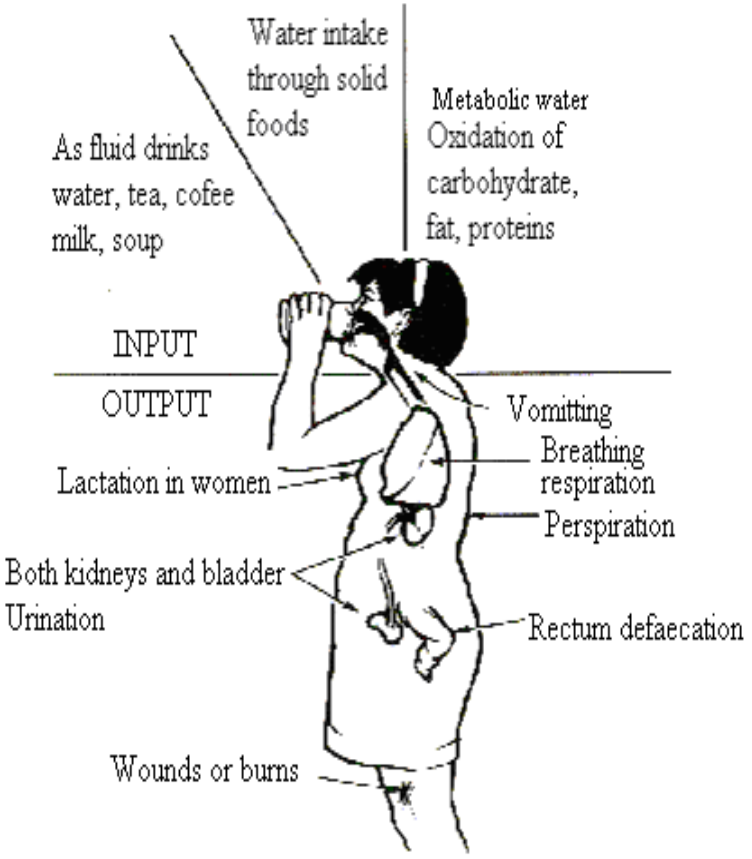


Fig 22.1 Intake of water and its output

Source : Susan.R.Holman,1987. Essentials of Nutrition for the Health Professionals.

Daily Water Input

In tropical countries like India the daily water input amounts to 2400 – 3000 ml of water through food, as fluid drinks and as metabolic water.

1. As fluid drinks – water, tea, coffee, milk soups	1500 - 1750 ml
2. Water intake through solid food	600 - 900 ml
3. Oxidation of carbohydrate, fat, proteins (metabolic water)	300 - 350 ml
Total	2400 – 3000 ml

22.2.2 Daily output of water

1. Urine	1200 – 1500 ml	à (kidney)
2. Perspiration	700 – 900 ml	à (Skin)
3. Respiration	400 ml	à (lung)
4. Faeces	100 – 200 ml	à (intestine)
Total	2400 – 3000 ml	

Therefore the water intake and output is fairly kept constant. This is called water balance. The average adult metabolises 2.5 – 3.00 litres of water and a constant balance is maintained between intake and output. Inadequate water intake disturbs water equilibrium resulting in decreased urinary output, thereby causing changes in Extra Cellular Fluid (ECF) and Intra Cellular Fluid (ICF). The water equilibrium is maintained by kidneys, lungs, intestine and pituitary gland. The water balance coordinates with both electrolyte and acid base balance.

22.3 CAUSES AND EFFECTS OF DEHYDRATION

Causes :

When water is constantly lost from the body as in severe vomiting, diarrhoea, excessive sweating or excessive urine formation due to treatment with diuretics, the total water content of the body is reduced. Extra cellular and intra cellular fluid decreases leading to dehydration.

Effects of dehydration

1. Tongue is dry.
2. Pinch test is done by raising and releasing the skin. Slow return of skin to original position indicates decreased ECF.

3. Decrease in plasma volume reduces cardiac output and may lead to cardiac failure.

22.4 PREVENTION OF DEHYDRATION

Dehydration can be prevented by taking sufficient amounts of water as fluids. The correction of dehydration is called rehydration.

Oral rehydration therapy

It is the administration of fluid to prevent or correct dehydration.

22.4.1 Oral rehydration salt

WHO, UNICEF formula consist of the NaCl – 3.5 g, $NaHCO_3$ – 2.5 g, KCl – 1.5g and glucose - 20 g to be dissolved in one litre of potable drinking water.

The Glucose present aids in the absorption of sodium chloride and potassium chloride apart from giving energy. This mixture is administered through the oral route at frequent intervals until the normal state is attained.

Potable water is that water which is safe and wholesome. It should be:

a. free from pathogenic agents

b. free from harmful chemical substance

c. pleasant to taste; free from colour and odour

d. usable for domestic purpose.

QUESTIONS

Part A

Fill in the blanks:

1) Administration of water or fluid orally to correct dehydration is called _____
2) Water which is safe and wholesome is called _____ water
3) The normal intake of water amounts to _____
4) The equilibrium between water intake and output is called _____

Part B

Write short answers:

1) How is water distributed in the body?
2) Enumerate the effects of dehydration and give the composition of oral rehydration salt.
3) Write short notes on Electrolyte balance and acid – base balance.

Part C

Write detailed answers:

Enumerate the functions of water in our body.

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